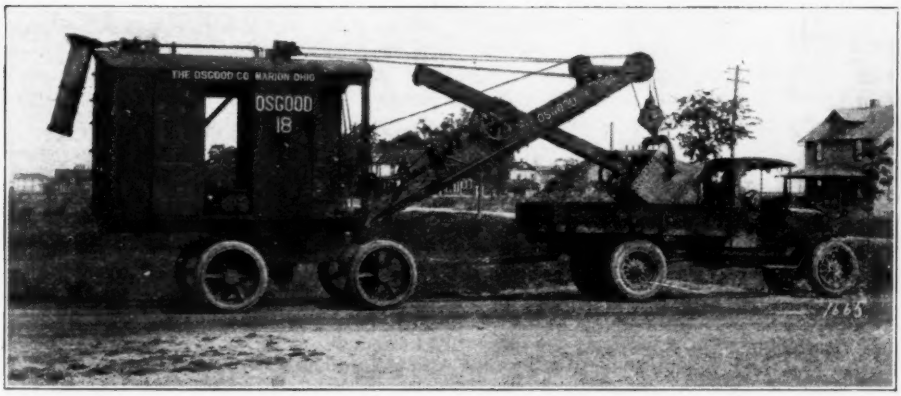
MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



MOTOR TRUCK TOWING OSGOOD STEAM SHOVEL. NOTE RUBBER TIRES ON THE SHOVEL TO PREVENT DAMAGE TO PAVEMENTS.

Motor Truck Operation and Accounting—77

HOW MODERN, MOTORIZED EQUIPMENT SPEEDED UP WORK ON JOHNSON CREEK, WISCONSIN ROAD JOB

Last season Peppard, Burrill & Connell, prominent Minneapolis contractors, built a section of concrete road 4.7 miles in length connecting Watertown and Johnson's Creek, Wisconsin.

After making a careful survey of the hauling situation they decided to use Kissel equipment. They selected the following equipment—a Kissel patented combination hopper and measuring box with a bin capacity of 20 yds. of stone and 10 yds. of sand, 9 special Kissel Road Builder trucks of 3-yd. capacity each, and a special designed turntable for turning loaded trucks.

In selecting equipment of this nature, Peppard, Burill & Connell figured that they would reduce their costs to a minimum, because they would eliminate one of the usual items of expense, namely delays.

It is interesting to see how the Kissel Road-builders carried out and systematized this work—from devising a hopper that saved hundreds of hours of time to delivering the batches in record time and turning and dumping into the mixer at a decreased cost in time, labor and money.

Work commenced on the road July 6th with favorable weather conditions. Sand and gravel were shipped in, the cars were unloaded by a crane and clam shell, and the material was put in two large stock piles where it could be quickly loaded into the bins of the hopper.

In order to appreciate the advantages of handling material in this manner from the standpoint of saving in time and labor alone, the following statistics regarding the time it takes to load hoppers, measuring boxes and trucks will prove interesting. The time required to unload one clam shell into bin is 35 seconds. Time required to charge the 9 measuring boxes is 12 seconds. Time required to empty 9 measuring boxes, 2 seconds.

There is no question but that the motor truck is the most efficient way to transport material, providing it is properly designed and equipped. It is necessary to go further than this, however, to make motor transportation practical. First, a contractor should have a standardized equipment, and second, proper supervision must be furnished. Unquestionably one of the greatest advantages which systematic supervision of motor equipment affords besides protection for the trucks, is the opportunity to keep every unit of the transportation scheme in constant, profitable motion. The ability of gasoline trucks to run without rest gives them a superiority over both horsepower and electric vehicles. The mechanic whose duty it is to see that the truck equipment receives proper care, should be carefully selected. They hold an important place in the contractor's organization. Remember the average road trucks receive more usage in 24 hours than trucks hauling for commercial purposes do in a much greater length of time, and therefore should receive the best of care when the day's work is done.

The driver has done his share when he drives eight or ten hours a day. He should not be relied upon to grease and oil the trucks. It is much better and more profitable in the long run to have an A-1 mechanic held responsible for greasing, oiling and overhauling the trucks.

The above method was used on the Johnson Creek job, with the result that it was one of the many items that helped to eliminate delays—the equipment was in tip-top shape every morning when it went out on the job.

The special Kissel road builders' truck is specially designed and adapted to meet all road-building requirements. In designing it, special attention was paid to the three leading truck factors essential for contracting and road-building work—power, durability and economy.

Kissel designed and built the proper powered motor for this job—a power plant fully capable to meet every power demand. It powers at 25 miles per hour loaded—and 30 miles per hour empty. It raises a 3-batch load in 10 seconds—unloading 3 batches in 7 seconds. It is particularly adaptable for grades and soft dirt roads. The power capacity is unlimited as contractors and owners assert.

A special double frame is used to insure flexibility and strength. Extra heavy springs not only insure proper

The Mack Light Bituminous Material Distributor

Your road maintenance next Spring

Now is the time to get ready

INCLUDED in our unusual line of special motorized equipment for municipalities, counties and contractors is this Mack Light Bituminous Material Distributor.

This equipment is a fool-proof machine for handling cold material and requires only a driver for its operation. The elimination of the extra operator which is usually needed on ordinary machines, means economy for its owner.

The tank body can be demounted when its particular work is done and a dump body substituted. This continuous chassis use effects large savings and many highway boards and commissioners are finding this a practical way to economize on their road maintenance equipment.

Mack TRUCKS

Capacities:
1½ to 7½ tons.
Tractors to 15 tons.

INTERNATIONAL MOTOR COMPANY
25 Broadway, New York

PERFORMANCE COUNTS

resiliency for full loads on uneven roads, but give added life to the entire body structure. Heavy duty front and worm-drive rear axles are regular Kissel equipment. A special short wheelbase is provided—with 36x6-in. front and 42x9-in. rear pneumatic cord tires.

A special 3-yd. capacity body of 8-gauge steel is mounted on a horizontal 2-cylinder hoist, operated from the driver's seat. Body is 9 ft. long, 6 ft. wide and 24 ins. deep, with single acting tail gate equipped with manual control and chain spreading device. Two swinging partitions divide body into three 1 cu. yd. compartments. Special sectional driver's cab and power tire pump are additional standard equipment.

The specially Kissel designed turntable was found to be a great time-saver on this job—the loaded truck comes down the grade to a point about 250 ft. in advance of the mixer. Here it runs onto the turntable and in 10 seconds it is turned completely around, ready for backing up to the mixer skip. This again saved time for the contractor as it has been tried and found to be impossible to turn a truck around on the grade as quickly and without cutting up the grade. Again, a few seconds were saved on each truck every trip, which is a material saving of time in a day's run.

The secret of success in truck hauling is to keep a truck loaded with material at the paver all the time, and by being able to do this Peppard, Burill & Connell were able to complete their 4.7 miles of paving in the record time of 40 actual working days.

For the benefit of the reader, we give herewith various data and statistics of progress from start to finish on the Johnson Creek, Wis., road job:

JOHNSON CREEK ROAD COMPUTATIONS
The Entire Job.
Average Daily Footage 620.4 feet.
Length of road 4.7 miles or 24,816 feet.
Total number of days on which any work whatsoever was done—40.

ONE WEEK'S WORK
Daily Average Footage 766 Feet.
In completing this job of 4.7 miles of concrete road, there was only one week in which the work was not delayed by rains and wet roads—the week of August 21st to 27th. The footage this week by days was:

Monday	681 ft.
Tuesday	711 ft.
Wednesday	903 ft.
Thursday	794 ft.
Friday	700 ft.
Saturday	866 ft.

Total footage for the week 4655 ft.
Number of days worked—6.

PROGRESS FROM AUG. 1 TO END OF JOB
Average Daily Footage of 736 ft.

During the period from August 1st to September 6th, when the job was completed, rain and wet roads prevented any work on 8 working days. On two days, namely, August 16th and 18th, only a half day's work was possible, due to rain. Despite this handicap, the total footage for this period was 15,447 ft. The number of days worked—21.

TIME CONSUMED IN OPERATING KISSEL TRUCKS AND EQUIPMENT.
Johnson Creek, Wis. Road Contract.

Loading, raising and emptying 1¼ cu. yd. clam into bin	35 seconds
Charging nine measuring boxes (6 boxes of 18 cu. ft. gravel; 3 boxes 10 cu. ft. sand)	12 seconds
Locking truck partitions—backing under hoppers—receiving load and starting on trip averages	25 seconds
Discharging 9 measuring boxes into truck	2 seconds
Speed of Kissel truck—loaded with 3 batches	25 M. P. H.
Speed of Kissel truck unloaded	30 M. P. H.
Turning loaded truck on turntable	10 seconds
Backing to mixer—dumping 3 batches into skip end and starting on return trip	4 minutes

JOHNSON CREEK FOOTAGE TABLE.

Work started	July 6, 1921
Finished	September 6, 1921

FOOTAGE TABLE.
Daily Average Footage—736 feet.
Highest Daily Footage—903 feet, August 24th.
(Showing daily progress after August 1st.)

Aug. 1—Rain	Aug. 14—Sunday	Aug. 28—Sunday
2—Rain	15—827 ft.	29—855 ft.
3—570 ft.	16—498 ft	30—318 ft.
4—742 ft.	(Rain 6 hr. wk.)	(Rain 4 hr. wk.)
5—711 ft.	17—Rain	31—Rain
6—723 ft	18—352 ft.	
	(Rain 4 hr. wk.)	
	19—615 ft.	
	20—Rain	Sept. 1—Wet Rd.
7—Sunday	21—Sunday	2—520 ft.
8—845 ft.	22—681 ft.	3—645 ft.
9—813 ft.	23—711 ft.	4—Sunday
10—Rain	24—903 ft.	5—Labor Day
11—Wet	25—794 ft.	6—520 ft.
Road	26—700 ft.	(End 6 hr. wk.)
12—620 ft.	27—866 ft.	
13—618 ft.		

Total footage after Aug. 1.....15,447 Total working days after Aug. 1.....21

(NOTE—Aug. 16th and 18th counted as one day, also Aug. 30th and Sept. 6th, as delay on these days due to rain.)

PERFORMANCE OF MACK TRUCKS ON ROAD AND STREET WORK

That the public in general appreciates the necessity of more and better highways is indicated by the fact that approximately a billion dollars are now available for building them in the United States. President Harding has emphatically declared his approval of a policy giving generous support to road-building and miantenance.

It remains only for the highway contractors to speed up operations, employing the best materials and methods, and the most modern equipment. A few typical instances of how this is being done, that have recently been called to our attention, are briefly outlined herewith.

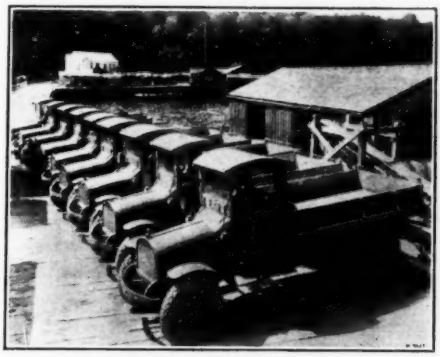
The fleet of nine 2½-ton Macks shown in the illustration, is operated by the Kaiser Paving Company, a large road construction concern in the Pacific Northwest, with headquarters at Seattle, Wash. These trucks have recently completed what was originally considered to be an impossible road-building contract of six miles in length on Vashon Island, in Puget Sound. Many difficulties surrounded this contract, including a steady 8 per cent grade for 1⅛ miles from the bunker, and the fact that the frequent and excessive rains in this section at times made the road almost impassable. The nine Macks were the only trucks used on this work.

Johnson, Drake & Piper, highway contractors of Minneapolis, recently created considerable interest among other contractors in that section by demonstrating without question the practicability and economy of using trucks for paving work. On a 15-mile paving project in Southern Minnesota the "dry batch" method was used, employing a centrally located proportioning hopper from which correctly measured batches of sand, crushed rock and cement were delivered simultaneously into the different compartments of the truck body. The truck equipment consisted of ten 2½-ton Macks with dump bodies divided crosswise in the center by a swinging partition.

After receiving the sand, crushed rock and cement, the truck proceeded to the multipedal mixer located on the road at a point where the paving was being laid, and discharged the rear batch first into the skip of the mixer. By elevating the skip, this batch was dumped directly into the drum of the mixer, and the skip was then lowered again to receive the second batch from the truck. The body of the truck was kept in an elevated position during the time the skip was delivering the first batch into the mixer, and the second batch was discharged simply by operating the trip lever on the outside of the body.

Each batch measured 30 cu. ft., and each truck carried two batches. Records of from 2½ to 3 miles of road construction per month were made.

In municipal work also the motor truck has not only met the demand for speeding up road work, but has complied with the requirements of modern machinery. This result has been brought about by furnishing the means of quickly carrying material from one point to another, for pulling light road-scrapers and road drags, and for rapidly covering long stretches of highway where a small amount of work is to be performed at widely separated points.



FLEET OF NINE 2½-TON MACK TRUCKS AS OPERATED BY THE KAISER PAVING CO., SEATTLE, WASH.

The results obtained by the use of the motor truck in several townships in New York State indicate that the motor truck on short hauls displaces four to five 2-horse teams, and on hauls over two miles displaces six to eight teams with a saving of from $6 to $15 per day in the performance of the same amount of work. In one instance, a 2-ton Mack, when attached to a light road-scraper, has proved to be the equivalent of two teams of horses in pulling power and does twice the amount of work.

MOTOR TRUCK NEWS NOTES

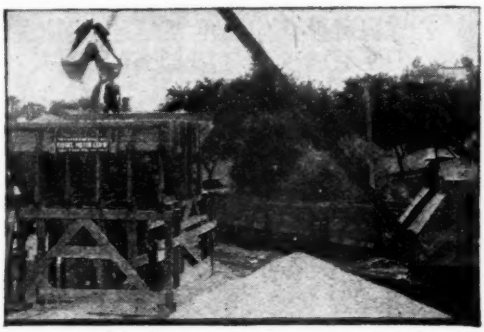
Modern Trucks Speed Up Highway Construction

Speed records in road construction work have been shattered during the last few

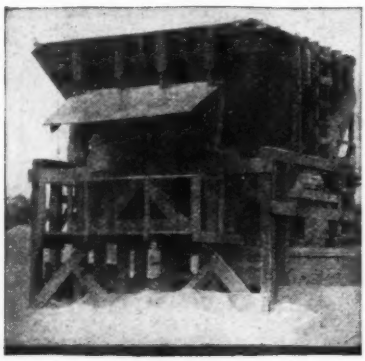
KISSEL

Actual working models of patented Hoppers, Measuring Boxes, Turntables and Trucks at the

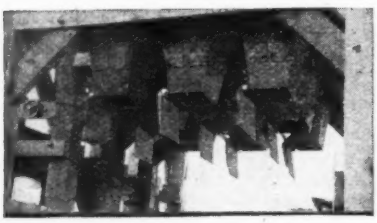
Chicago Good Roads Show, Coliseum, January 16-20, 1922.



Loading the bins in the Kissel patented Hopper with clam.



One man easily operates levers that control the dumping of measuring boxes into truck.



Interior of Kissel patented hopper showing loading funnels of measuring boxes built into top of hopper.

Kissel Special Road-builder's truck on specially designed turntable,

Loads Correct Amount of Sand, Gravel or Cement into Trucks in Two Seconds

THE Kissel patented combination hopper and measuring boxes (patent applied for) have revolutionized handling and loading materials—eliminating waste, saving time and labor.

The Kissel hopper has a storage bin capacity of 20 yards of stone and 10 yards of sand. Equipped with 9 measuring boxes—3 boxes with a capacity of 10 cu. ft. of sand, and 6 boxes of 9 cu. ft. of stone. Measuring boxes equipped with a patented adjustable arrangement so that capacity can be varied quickly and easily.

One clam shell loads bin in 35 seconds—measuring boxes loaded in 12 seconds. Three batches dumped into truck in 2 seconds.

Where trucks haul a dry mix, trucks stop only 2 seconds under Kissel cement hopper to receive properly measured portion of cement.

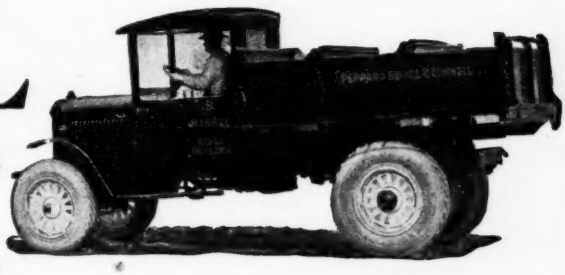
Loaded Truck Completely Turned Around on this Turntable in Ten Seconds.

Simple and durable in construction—unusually efficient to operate—saves wear on truck and final grade—mounted on skids for easy moving by truck—strongly built—rollers equipped with bearings.

This important time and labor-saving device is placed about 500 feet in front of the mixer—the loaded truck drives right upon it, where it is turned around in less than 10 seconds, preparatory to backing up to the mixer.

KISSEL MOTOR CAR CO.
HARTFORD, WIS., U.S.A.

KISSEL



Special Road-builder's Truck will be Exhibited at

Chicago Good Roads Show, Coliseum, January 16-20, 1922

Specially Designed and Built—Geared and Powered to carry a 3 cubic yard load from Hopper to Mixer on an uninterrupted schedule.

CONTRACTORS' and roadbuilders' requirements demand the dependability, economy and durability of Kissel's special Road-builder's truck—avoiding the slow-ups that delay daily footage.

Throughout 1920 and 1921, these trucks in the hands of owners proved not only unusually economical, but thoroughly dependable, easy to handle, with plenty of power and ability to carry full loads.

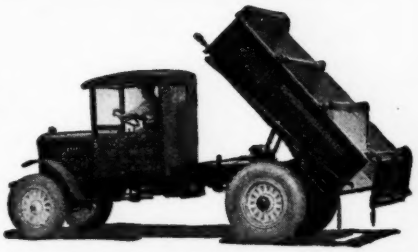
In the Kissel special Road-builder's truck the Kissel engineering department paid special attention to the three leading truck factors for contracting and road-building work—

POWER — DURABILITY — ECONOMY

Power—Kissel designed and built the proper powered motor for this job—fully capable to meet every power demand. Speed 25 miles per hour empty and 20 miles per hour loaded. It raises a 3-batch load in 10 seconds, unloading 3 batches in 7 seconds.

Durability—A special double frame insures flexibility and strength. Extra heavy springs give proper resiliency for full load on uneven roads and added life to the entire body structure. Heavy duty front and worm-drive rear axles are regular Kissel equipment. A special short wheelbase is provided.

Economy—Due to careful engineering, quality materials, oversize units and sturdy construction, the Kissel special Road-builder's truck is not only unusually economical, but practically free from repair work.



Kissel special Road-builder's Truck with body divided for three batches of one cubic yard each.

Special double frame and extra strong springs on Kissel special Road-builder's truck.

Body Equipment—A special 3-yard capacity body is mounted on a horizontal hoist, operated from driver's seat. Body is 9 ft. long, 6 ft. wide, and 24 ins. deep. Special sectional driver's cab and power tire pump are additional standard equipment.

Kissel Road Division will Furnish Trucks with Drivers, Hoppers, Measuring Boxes and Turntables to handle your haulage work.

Occasionally a contractor is not in the market for equipment, but prefers to sub-let his hauling. Kissel road engineering service has a plan whereby a bid will be made on your hauling—provide a fleet of Kissel special Road-builder's trucks, each one driven by its owner—a Kissel patented hopper with measuring boxes and turntable—operated under proper supervision and furnished with the best service facilities—taking over your hauling problems and systematically keeping up an uninterrupted flow of material to your mixer.

Special Kissel Exhibit at Chicago Good Roads Show

The special Kissel Exhibit at the Coliseum Good Roads Show, January 16th to 20th, will consist of complete working models of the Kissel Patented Combination Hopper and Measuring Boxes, Turntable, and Special Road-builder's Truck. Don't miss it.

KISSEL MOTOR CAR CO., Hartford, Wis., U.S.A.

months as a result of a more rapid handling of raw materials, according to contractors.

The increasing use of motor trucks during the last few years aided greatly in accelerating the building of roads, but recent improvements in motor truck design have enabled operators to haul more materials than ever before.

As an instance of this may be cited the Montclair-Danville road near Newark, N. J., completed recently. The contractors laid this 20-ft. concrete highway at a rate of more than 700 ft. a day. The materials had to be hauled an average of four miles, but motor trucks maintained a steady flow of crushed stone and other materials.

Among the trucks on this job were four Pierce-Arrow units of the Dual Valve type, equipped with dump bodies. These trucks develop greater pulling power and hill-climbing ability than any truck yet designed, and as a result they easily outstripped the other trucks in making the run between the stone hoppers and the concrete mixers four miles distant. The route led them over the Hook Mountain hill, which they ascended, fully loaded, in high gear, while the others crawled slowly up in second or third.

This test which involved continual deep ruts, mud and chuck holes, demonstrated the ability of the Dual Valve trucks so forcefully that the truck operator, Mr. Eugene Wendling, of Newark, purchased six additional Pierce-Arrow units.

New General Motors Truck Prices

The General Motors Truck Company, of Pontiac, Mich., announced this week a substantial reduction on its line of heavy duty trucks to become effective Jan. 1.

These new prices represent a reduction from the original price of these models ranging from $625 to $1,050 per chassis, and are as follows:

2-ton (Model K-41).....$2,775
3½-ton (Model K-71).....$3,950
5-ton (Model K-101).....$4,350

The one-ton chassis of this series was recently reduced to $1,495. In announcing these reductions, Mr. W. L. Day, President and General Manager of the General Motors Company, stated:

"These new prices are in keeping with the spirit of the times. There is greater need today for economical, efficient motor transportation than perhaps ever before. In fact, it is vitally essential to the future stability of business. The more extensive use of high grade dependable motor trucks at this time will assist materially in reducing delivery costs which are big items in overhead expense in all lines of commercial and industrial activity.

"This saving that motor trucks effect will permit in turn the lowering of prices on the finished products, and thus create a healthy trade stimulus which will hasten the period of normalcy and general business prosperity to which we are all looking forward.

Handling War Truck Bodies

When the Indiana State Highway Commission was recently allotted 15 ex-military F. W. D. trucks by the Government for highway construction and maintenance purposes, they immediately started overhauling and equipping them for service.

When the trucks were nearly ready for the road, the question of proper body equipment came up for solution. To purchase new bodies would have meant the expenditure of quite a large sum of money and the scrapping of the ammunition bodies, which came with the trucks. That is not what was done, however—they cut the ammunition bodies down and at almost no expense made them into 2½-yd. dump bodies, which will answer the purpose as well as any $250 or $300 body.

KISSEL DISPLAYS COMPLETE ROAD BUILDING EQUIPMENT AT CHICAGO GOOD ROADS SHOW

An exhibit of road building equipment and engineering that will attract unusual attention at the Chicago Good Roads Show at the Coliseum January 7th to 20th, will be that of the Kissel Motor Car Company. In addition to a completely equipped Special Kissel Road Builder's Truck, quarter size working models of the Kissel patented hopper and measuring boxes and special designed turntable will be shown, thus enabling visitors actually to see how this special engineering equipment operates in loading trucks with the correctly proportioned batches.

These miniature models of the hopper and measuring boxes will also enable visitors to see just how it is constructed and the simplicity with which it is loaded and dumped—also how the measuring boxes accurately measure the correct proportion of sand, gravel or cement. A noteworthy feature of these measuring boxes is that

they are adjustable to the varied sizes of loads desired by the contractor.

The miniature turntable will be exact in every detail to the actual turntable used on contracting jobs, and which completely turns a loaded truck around in less than 10 seconds.

Included in these quarter size models will be a quarter size replica of a Kissel Special Road-builders' truck—the idea of the manufacturers being actually to operate these four engineering features from the loading of the hopper to dumping the correctly proportioned load into the truck —the truck driving onto the turntable where it will be actually turned around preparatory to backing up to the mixer, where each batch is automatically dumped into the skip.

The special Kissel Road-builders" trucks are equipped with a hydraulic dump body of 3-batch capacity of 1 cu. yd. each, designed, geared and powered with the proper flexibility, power and speed for every economical service necessary to meet contractor's requirements.

In addition visitors at this exhibit will see how Kissel engineering service enables contractors to lay the greatest amount of finished road in the shortest time and at the lowest possible cost, enabling contractors to increase their daily footage at a decreased expenditure in time, labor and money.

It will be interesting to visitors to learn that the different Kissel road engineers will be in attendance at the exhibit throughout the length of the show. These are the engineers who supervise the trucks and equipment operating on a systematized schedule, keeping up a continuous flow of material from the hopper to the mixer, enabling the latter to operate every second throughout the working day. These engineers will have with them complete data and figures showing the economical and efficient operation of both the trucks and equipment and this together with the opportunity of visitors to see this equipment in actual operation, will be one of the most interesting events of the show.

NEW AUTOCAR MODEL AND PRICES

The Autocar Company of Ardmore, Pa., recently announced a new schedule of prices, effective Jan. 3, 1922, for its standard 1½ to 2-ton Autocar and for its 5-ton Heavy Duty Autocar. It announces also a new model Heavy Duty 2-ton Auotcar.

The price of the standard 1½ to 2-ton Autocar, with its over-all capacity of 11,000 lbs., was reduced from $2,300 and $2,400 to $1,950 for the 97-in. wheelbase and $2,050 for the 120-in. wheelbase.

The new 2-ton Heavy Duty Autocar chassis, with a four-cylinder motor and an over-all capacity of 14,000 lbs., is priced at $2,950 for the 114-in. wheelbase and $3,075 for the 138-in. wheelbase.

The 5-ton Heavy Duty Autocar, with its over-all capacity of 22,000 lbs., is priced at $3,950 for the 120-in. wheelbase and $4,100 for the 156-in. wheelbase.

The unladen chassis weights of these six models are as follows:

Type F, 3,600 lbs.; Type G, 3,700 lbs.; Type H, 5,200 lbs.; Type K, 5,350 lbs.; Type Y, 7,200 lbs.; Type B, 7,400 lbs.

CONCRETE MIXER WITH ENCLOSED TRANSMISSION

Among the interesting exhibits in paving equipment at the National Roads Show to be held in Chicago, January 16 to 20, will be the 1922 model of the Rex Paver, manufactured by the Chain Belt Company, Milwaukee.

This is the machine which has attracted considerable attention during the past year because of its enclosed type of transmission. The Chain Belt Company is the first to have made use of this type of transmission, so successful with motor trucks, on paving machines. The enclosed transmission has proven highly successful on paving mixers.

Another distinctive feature that will attract the attention of highway contractors is the enclosed power-operated discharge of the Rex Paver. All gears operate in oil, so that the manipulation of the discharge chute is not only very easy, but also remarkably fast. The swinging of the chute responds almost instantly to the touch of the lever.

The Paver on exhibition will be equipped with the full-length type of traction adapted to the three-point suspension principle. A new type of Rex Distributing bucket will also be shown.

The company also plans to exhibit a central mixing plant mixer with features that are a radical departure from present mixer standards.

Concrete Road Building Breaks All Records

62,000,000 square yards of Concrete highway pavement—equivalent to 6000 miles of 18-foot road—were built last year. This is nearly double the amount built in any other year.

People demand roads which give the greatest measure of service, saving and safety. That is why highway officials everywhere are building Concrete hard-surfaced roads. They know from experience no other road performs like Concrete.

PORTLAND CEMENT ASSOCIATION

A National Organization
to Improve and Extend the Uses of Concrete

Atlanta				San Francisco
Chicago	Detroit	Los Angeles	Parkersburg	Seattle
Dallas	Helena	Milwaukee	Pittsburgh	St. Louis
Denver	Indianapolis	Minneapolis	Portland, Oreg.	Vancouver, B. C.
Des Moines	Kansas City	New York	Salt Lake City	Washington, D. C.

EDITORIALS

ADMINISTERING ENGINEERS' LICENSE LAWS

This magazine has always been in favor of engineers' license laws, believing that such laws, if properly formulated and administered, will raise the standards of engineering practice, increase the earnings of the competent engineers by gradually eliminating the incompetent, and protect the interests of the public. In our advocacy of licensing we always took for granted that when any state enacted an engineers' license law that all the engineers of the state would be granted licenses on application except in the case of individuals known to be dishonest or incompetent. In other words, it was our belief that changes resulting from licensing would be brought about gradually with a minimum disturbance to the existing conditions at the time the law became effective. We did not suppose that there would ever be a board, anywhere, that would refuse to issue a license to a man because he had long since forgotten certain academic knowledge in his preoccupation with affairs of consequence; we did not suppose any board would presume to say that certain engineers were practicing professional engineering while others in the same office engaged on the same tasks, but with junior titles, were not practicing professional engineering. Now we are dismayed to find that these faulty interpretations of license laws are working a hardship on individuals, are creating strife where only harm can result, are undermining the license idea itself and are threatening to do grave injury to the profession.

The subject is a large one and no attempt will here be made to consider its every aspect. We merely wish to point out, in all friendliness, that it is dead wrong, for example, to withhold a license from a thoroughly competent municipal and sanitary engineer who wants to design a water filtration plant for a city because he flunks when suddenly required, by a board of examiners, to design a crane for handling ore. It is also wrong to say that a city engineer is practicing professional engineering, but that his principal assistant, to go no further down the line, is not. It is also wrong to say that a man doing a certain grade of work for a fee is practicing professional engineering, while a man doing exactly similar work on a salary is not a professional engineer. These illustrations merely serve to indicate some of the perversions in administration which have come to our attention.

Nearly every engineer with whom we have discussed this subject feels quite convinced that the license laws will be repealed unless they are administered with common sense. Attempts to make their provisions retroactive in detail and to revolutionize speedily nearly all accepted professional concepts and usages will soon kill off these laws.

In our opinion the greatest danger arising from this maladministration is the attempt to divide engineers into "sheep and goats," to use a biblical allusion, with the goats very much in the majority. Let us be mighty careful how we handle the younger men in the junior grades of practical engineering work. They feel that they are practicing professional engineering and we emphatically agree with them. Can they be expected to continue to comport themselves as professional men if the constituted authorities of the state tell them they are not professional men?

The question does not concern the honesty or integrity of these boards; that they want to elevate the profession no one will deny. The question is merely as to the wisdom of certain practices which are beginning to take form. We urge the boards to proceed in a liberal spirit, striving for ultimate rather than immediate perfection.

STREET AND HIGHWAY LIGHTING

There is a new interest in highway lighting and a renewed interest in street lighting, due to motorized traffic. Cities once considered well lighted are revising their lighting systems as the normal pursuits of community life are being resumed. During the war lighting was sometimes not wanted at all, and in other cases existing facilities were considered

quite satisfactory for the time being. It was during this period, when little thought was given to lighting, that motorized traffic increased so rapidly, rendering inadequate the lighting systems which had served well enough for pedestrians and slow-moving horse-drawn vehicles.

The fact that motor vehicles carry their own lights adds to the difficulties of the problem, for such lights are often as much a menace to other vehicles as a protection to the one they are on. Every motorist has learned to dread the glaring headlight and also the tail light that is out of commission or which is not burning, due to the carelessness of the driver. Cars parked at the curb in the afternoon of winter days oftentimes remain dark long after nightfall and form dangerous obstructions in narrow streets. Many streets are so poorly lighted that the motorist's dim lights are insufficient and he is thus forced, in self-defense, to use his bright lights in a manner that adds to the total of traffic accidents. The remedy for this condition lies quite as much, or more, in improved street lighting as in the regulation of automobile lighting, which, like most attempted regulation of motoring, usually proves abortive.

While city lighting requirements have been changing, an even greater change has occurred on country highways, which have passed from thoroughfares on which lights neither existed nor were expected to ones requiring lights and having them, in a few cases. In fact, highway lighting is of more acute interest, in many ways, than street lighting at this time. That is, there is often greater need for at least a beginning in highway lighting than for improved street lighting. Fast motor traffic on dark and comparatively narrow country roads leads to many accidents and to much eye and nerve strain. There are circumstances under which it is flying straight into the face of providence for the motorist to refrain from using his bright lights, and, under such circumstances, he will continue to use them regardless of still-born headlight laws on the statute books.

It has been found that the installation of a thoroughly modern and adequate lighting system adds but a very small percentage to the first cost of a hard-surfaced road. It is unnecessary to enumerate the primary advantages of such a system, but there are secondary advantages of real importance which are deserving of consideration. To light a highway requires the running of a line out into the country, of course, and this brings electricity, with all of its benefits, within reach of many country homes. It is only a question of time when all modern roads will be patrolled by a state constabulary in an effort to cope with the miscreants who are now robbing with impunity. The efficient functioning of such a force will require good lighting.

We suggest to city officials that they investigate their street lighting equipment to test its efficiency under present-day requirements. Not only have conditions changed since many lighting systems were installed, but there have been advances in the art introducing elements of efficiency and economy which any city may adopt with profit to itself. It is urged, also, that serious consideration be given to the lighting of the more important highways carrying a heavy traffic.

BIND YOUR COPIES OF M. and C. E.

At the beginning of a new volume, with this number of Municipal and County Engineering, we are again urging our readers to preserve and bind their copies of this magazine. Articles of permanent value appear in each issue. The size of the paper, readopted one year ago, is well suited to binding, as it is substantially that of most of the text-books and catalogues that engineers and contractors keep on their book shelves.

It is suggested that after each copy is received and read it be placed where it can be found and subsequent numbers added to it. At the end of six months or a year it is a simple and inexpensive matter to send the copies to the binder to have them trimmed and bound into book form. Many readers, of course, have followed this practice for years, and they now have, in their bound volumes of this magazine, a comprehensive treatment of all phases of public works engineering.

The index for Vol. LXI, July-December, 1921, is now ready for distribution and will be sent free to any one who requests it.

IMPORTANT CONSIDERATIONS IN RECONSTRUCTING CITY PAVEMENTS

By Harlan H. Edwards, City Engineer, Danville, Ill.

(Editor's Note:—The present article calls attention to the fact that incidental work on resurfacing jobs may prove of major importance and describes a combination of concrete header curb with steel paving guard which proved successful along car tracks.)

Many of our city pavements laid down 25 or 30 years ago are getting to the point where they must either be rebuilt, or resurfaced with one of the several forms of bituminous pavement. Quite a few of these old pavements are of the block type which have either worn into chuck holes or have become rough by the settlement of the foundations under the increasingly heavy traffic. Some are old stone or gravel streets, some are of the bituminous type, while a few are of concrete, laid in the early days when "soupy" concrete was permitted. The "smoothing up" of these old streets constitutes much of the work of our modern street departments.

To rebuild or replace the wearing surface of most of these old streets is simple. In many cases merely the wearing surface is worn out, leaving thoroughly compacted foundations upon which new wearing surfaces may be placed. In such work no change of grade is involved, hence there is little work to be done other than strictly repaving.

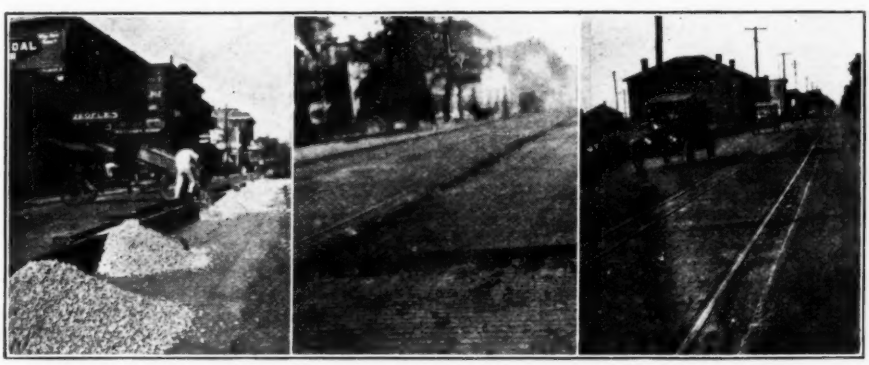
Looking After Street Drainage on Resurfacing Jobs

When one undertakes to resurface a street, however, entirely new problems are introduced which are separate and distinct from the laying of the pavement itself. A new wearing course placed upon the old one brings the street and gutter level several inches above that of the original pavement, decreases the curb height and consequently the gutter capacity, and blocks the free drainage of surface water from intersecting streets and alleys to the street being resurfaced. It is seen, therefore, that unless the street in question is situated upon a ridge, with all cross streets and alleys draining away from it, the additonal problem of street drainage is injected into the proposed improvement.

A thorough and complete system of storm water drains is an essential part of nearly all resurfacing jobs. On account of the reduction in curb height, inlets or catch basins must be placed closer together along the street and their clear opening, free from all possible obstructions, be made large enough that all the water falling upon or flowing upon the street will be removed quickly in order that the sidewalks and basements of buildings adjoining will not be flooded. If this is not done, it is very likely that the city will be subjected to many lawsuits and claims for damages on this account.

Wherever new drains have been placed in the street, the trenches must be thoroughly backfilled, then spanned by a reinforced concrete slab having a bearing of at least 1 ft. on each side of the trench as dug. The surface of this slab is placed at the elevation of the old pavement. If this is not installed, settlement of the street at this point is inevitable.

In some cases it may be necessary also to lower alley turnouts before resurfac-



CONCRETE HEADER CURB CONSTRUCTION ON CAR TRACK STREET IN DANVILLE, ILLINOIS.

Left: Header Curb Protects Pavement while Track Structure is Being Replaced. Center: Header-Curb with Steel Paving Guard Holds Bituminous Top in Place. Right: Header-Curb with Brick Pavement. Note Condition of Pavements on Each Side.

ing, so that proper drainage may be accomplished, and in order that the paving be not placed above the sidewalk level. In many cases here, this necessitates the construction of a new foundation along this portion of the street, thus adding quite a little to the total cost. Additional drains and inlets can sometimes be eliminated in this way, the slope of the turnout being decreased somewhat thereby. At all paved intersecting streets and alleys, it is necessary to take up and relay the pavement from the end of the resurfaced street for a distance of about 10 ft., so that travel on these streets be not inconvenienced by a sudden rise or fall in the street level.

All of the foregoing items are things which must be done in the resurfacing of a street, but which are seldom mentioned when speaking of the cost of the improvement. In some instances it may be much cheaper to replace the old wearing course with a new one of similar material, keeping the street at its original elevation.

Using Header Curb in Resurfacing Car Track Streets

It is frequently the case that the street to be resurfaced is one of the principal thoroughfares, upon which a street car line is operated. Resurfacing such a street involves an additional item—that of raising the car tracks to conform to the new grade. In some cities the street railway company has been installing new rails and repaving without argument. In other cities, however, the railways have refused to assume this expense outside the cost of repaving, arguing that the expense was unwarranted and could be eliminated by replacing the old wearing surface with a new one without raising the grade.

In connection with this work, the use of the concrete header curb having a steel paving guard embodied in its surface has proven of great merit and value to everyone concerned—especially where bituminous surfaces have been placed upon the old pavements with granite block or brick in and along the car track. On North Vermilion Street, Danville, Illinois, a 6x24-in. concrete header curb having a 3x2x5/16-in. steel angle paving guard embedded in its surface, was built with its outer face 14 ins. outside the outside rails of the car track, and having the top of the paving guard at the grade of the new surface of the street. This was installed at a price of $1.25 per linear foot complete, using forms only on the face of the curb nearest the car tracks. The new pavement surface was laid, and opened to traffic before work on rebuilding the car track commenced. In this case full advantage was taken of the possibilities of this curb, for in the subsequent work, the car track was completely removed leaving a trench 20 ins. deep in which new ballast, ties, etc., were placed for the new track. The header curb formed the sides of the trench, relieving the car company from any trouble from that source, and protecting the city's pavement from any possible damage. This header curb has the added advantage of permanency, inasmuch as it is below the surface of the street, and receives no wear.

Encroachment of the car company beyond their franchise rights is prevented by the use of the header curb. In many cities the franchise of the car company calls for but 1 ft. outside the outside rail of the tracks. Upon investigation it is found almost invariably that the ties extend nearly a foot beyond this. The pavement along these tracks is usually in bad shape, while track maintenance men are found in some instances digging up the paving 6 to 8 ft. to the side of the track in order to remove a bad tie and put in a new one without taking up a rail. Such ruinous practice is entirely eliminated by the installation of the header curb. This type of curb is also obtainable in granite and wood block, making a very serviceable and unnoticed protection in streets of this character.

THE "RUTTING" AND "ROLLING" OF ASPHALT PAVEMENTS

By Hugh W. Skidmore, Consulting Engineer, Chicago Paving Laboratory, Inc., 160 N. Wells St., Chicago, Ill.

(Editor's Note:—This discussion places particular stress on the unwisdom of the indiscriminate use of standard specifications and calls particular attention to the relation between bitumen content and fine material. This represents one of the most important features of asphalt construction which now requires the sort of investigation and constructive criticism which will lead to the correction of faults in the use of this excellent paving material.)

Users of asphalt have lately become familiar with the expression, "Proved through the Ages," through the display of this appositive on the literature of the Asphalt Association. The fact that this material has demonstrated its durability implies a knowledge of its limitations as

well as of its adaptability, and indicates passage through the early or experimental stage of development. That is to say, a great deal has been learned as to where and how this very valuable material may be useful. In consequence of added knowledge pertaining to the various methods and means governing the use of bituminous cements, certain standards have been evolved. Changing service conditions from time to time have made necessary modification of standard practice.

Paving mixtures of 25 or 30 years ago—yes, of even 10 or 15 years ago, may not meet present-day traffic requirements. This is true despite the fact that many pavements are to be found which have been giving very satisfactory service for more than 30 years. The existence of a more or less limited yardage of old pavements which are still in a fair state of preservation, does not lead to the conclusion that certain modifications of old standards are not now advisable.

While it is sometimes necessary to resurface or replace asphaltic type pavements before a reasonable period of service has expired by reason of such failures as surface distortion, subsidence of subgrade, foundation failures, failure properly to replace openings in the pavement structure, etc., it is rarely ever necessary to relay an asphaltic pavement which has literally worn away. Thereore, there would seem to be ample evidence that either certain standards under which pavements have been designed may be improved or that such standards are not applied with a proper understanding of the modifications which may be necessary in order properly to meet existing service conditions.

By far the most serious criticism to be offered against asphaltic wearing surfaces, judged by their performance during the past few years, is the displacement of the composition under traffic. This defect may occur generally throughout a given piece of pavement, or it may be confined to limited areas. It does, however, exist to such an extent that the cause cannot be assigned to a few loads of paving mixture which failed to comply with the established formula.

Limitations Not Understood

The extent of "rutting" and "rolling" in some localities usually indicates just one thing—lack of definite understanding of the limitations pertaining to the use of asphalt as a cementing medium in its relation to the fine aggregates used in the pavement composition. Although slight variations from this proper ratio may not alone seriously affect the stability of the mixture when accompanied by the use of asphalt of suitable consistency—stability is greatly reduced during warm weather when too soft an asphalt is used. The reverse of this rule is not strictly true; i. e., a poorly balanced mixture may not be rendered stable solely through the use of an asphalt of suitable consistency.

In the great majority of cases it will be found that the cause of failure does not lie in the quality of the asphalt, and in no small number of cases it has been positively demonstrated that mechanical features of construction are either directly or indirectly the cause of pavement failure. Assuming that reasonably durable aggregates are used, density of finished mixture becomes the most important desideratum so far as longevity of the pavement composition is concerned. While it is true that the compressability of the mixture is largely dependent upon the grading of the mineral matter, it is also true that in a given mixture, much greater density is secured by the use of heavier rollers than are ordinarily employed.

Rolling

Another very important consideration in the matter of rolling which is not yet generally well enough understood by engineers and contractors, is the fact that the first rolling or surfacing of the hot mixture produces very nearly ultimate compression. Any mixture which will not sustain a roller of ten or twelve tons weight for the first rolling is improperly designed. There still seems to be a strong misconception in the minds of many to the effect that if the light roller performing the first rolling does not supply sufficient compression, subsequent rolling as the mixture cools will compensate for this deficiency. Although subsequent rolling may produce a certain amount of compression, the fallacy of the belief that such will be of any very great consequence is rapidly demonstrated by means of a comparison between the density of a mixture which has received only the first rolling and the same mixture after final rolling.

Blame Attaches to "Standard Specifications"

No small share of the blame for pavement failures falls upon the commonly termed "standard" specification. Any standard as applied to a structure at best represents only an average and requires adaptation to meet the needs of a specific case. The danger, of course, lies in the

possibility of the standard being applied literally. Certain standards are necessary and valuable as a working basis from which to develop suitable design, but the use of such standards is contingent upon knowledge of their limitations. Of all the so-called "standard" specifications, undoubtedly the old Topeka formula is the least reliable when construed literally. In fact, it is rather surprising that this particular specification should have ever acquired the name "standard." The very conception of this formula belies the logical sequence of experience through which standards are evolved. This mixture is not a true concrete conglomerate of either the coarse or fine mixture type, therefore it does not possess the necessary stability to withstand the traffic forces common to the average city pavement or arterial highway. Modification of this formula becomes necessary in order to insure reasonable durability except perhaps in cases where the pavement will receive only very light residential traffic. Either the mixture must have more stone and less bitumen or less stone and somewhat higher limits for the bitumen content, depending upon the intensity of traffic, kind of foundation and the use of a binder course. The coarser mixture prevails where no binder is used and the traffic is restricted to pleasure cars or is of low intensity.

Investigation of Defects in Pavements

Examination of "rutted" and "rolled" pavements in a number of cities for the purpose of determining the cause and advising a cure, has shown that in the great majority of cases mixtures have contained insufficient fine mineral and an excess of bitumen. The investigation in such cases should include a careful examination of the pavement and a study of the traffic conditions; analysis of the mixture; density of the mixture; consistency of the asphalt cement, and microscopic examination of the minerals used. It may be of interest to refer here to one or two of the actual cases which were investigated. In one city where "rutting" and "rolling" were very pronounced in both sheet asphalt and coarse mix asphaltic concrete; analysis of mixtures showed as high as 10 per cent bitumen in asphaltic concrete which carried only about 10 per cent of mineral passing the 80 screen, and as high as 14 per cent and 15 per cent of bitumen in sheet mixtures with less than 30 per cent of mineral passing the 80 screen of which less than one-third passed the 200 screen. In another instance an asphaltic mixture had rolled badly in certain portions; analysis of this mixture taken from the affected areas was as follows:

Bitumen	10.35%
Passing 200 mesh	10.62%
Passing 80 mesh	7.87%
Passing 40 mesh	21.10%
Passing 10 mesh	23.84%
Passing 4 mesh	21.47%
Passing 2 mesh	4.75%

There was such an excess of bitumen that a cross-section of the mixture exposed globules of pure asphaltic cement almost as large as a peanut kernel. The sample was taken after cool weather had prevailed for a short time and the effect of summer temperatures in drawing the bitumen to the surface was readily discernible in the cross-section.

Such examples as these illustrate inconsistencies in the proportioning of constituents as would quite obviously result in displacement of the mixture, but, when mixtures which at one time might have been considered "normal" are found to distort under severe traffic, the investigator is impressed with the fact that there exists a very delicate balance which must be maintained in the ratio between fine mineral and bitumen and that the limits of this ratio decrease as the intensity of traffic increases. In comparison with the analysis mentioned above, a sheet asphalt mixture was designed for the downtown traffic in a Western city with the bitumen from 10 to 10.5 per cent, stone dust passing 200 mesh screen, including a very small amount of fine sand, 18 to 22 per cent, and sand passing the 80 screen and retained on the 200, 25 to 30 per cent. This pavement was laid using three heavy rollers. A very smooth surface and high density resulted. In another city where a heavy traffic mixture was designed, the first rolling of the sheet asphalt was effected by a 3-wheeled roller weighing 12 tons. The two 8-ton rollers finishing readily removed all of the roller marks left by the 3-wheeler. Asphalt of 35 to 40 penetration was used in both of these instances.

Consistency of Asphaltic Cement

The intensity and weight of traffic are the controlling factors in establishing the working consistency of the asphaltic cement. Except in extreme cases, there is little if any call for penetrations to be lower than 35 to 40, or higher than 60. This statement applies to mixed type pavement, and includes the binder course in which the asphaltic cement should have

the same consistency that is set for the top course. Often there is too much importance assigned to the matter of variations in penetrations. While it is true that the consistency of the asphaltic cement is an important factor in the manufacture of an asphaltic wearing surface, restriction as to the limits is frequently very much overdone. In the first place, when asphalts are fluxed at the paving plant, the penetration cannot be controlled within very narrow limits except by the expenditure of more time and effort than practical purposes require. Secondly, in a properly proportioned mixture which carries sufficient fine mineral matter for the traffic, five or six units of fluctuation in either direction from the working consistency will not be a serious matter so far as the durability of the mixture is concerned; provided that in the first place the working consistency was set low enough.

Application of Knowledge Gained by Investigation

The knowledge obtained from thorough investigation of pavement failures, if properly used, will prevent the duplication of the same mistakes in future work, and may very well indicate the means of correcting errors in the pavement under investigation. Work along this line has been done by the Chicago West Parks in connection with asphaltic concrete pavements on boulevards which have rutted. The mixtures were first analyzed and the deficiencies noted: the wearing surface in the affected areas was then removed and run through a reheating plant, where the deficient materials were added and the mixture was relaid. Sections of pavement so treated thus far indicate that the structural weakness which permitted the displacement of the composition has been corrected. This work, although on so small a scale as to make impossible construction economies, was done at a cost very much less than the cost of resurfacing. When a defective mixture can be so easily corrected, at a cost much less than the cost of resurfacing or relaying, a great saving is offered to taxpayers by this means of protecting their original investment. An asphalt pavement only five or six years old has a potential additional life of 10 to 15 years or more. This being true, the possible saving to be effected by remixing any portions which in the early years develop "waves" and "ruts," is readily apparent.

INSPECTING MATERIALS USED IN CONSTRUCTING ILLINOIS HIGHWAYS

By H. F. Clemmer, Testing Engineer, Illinois Division of Highways, State House, Springfield, Ill.

With the introduction of the immense highway building program in 1918 which called for hundreds of miles of paved roads involving the expenditure of millions of dollars, Illinois was faced with the problem of securing efficient inspection of road materials. So satisfactory has this problem been solved that no change from the present system is mentioned in the outline for construction for 1922, which calls for the building of far more miles of paved roads than have ever before been built in one year by any state in the United States or single province of a foreign nation.

Field Inspection

Field inspection of highway materials in Illinois on a large scale began in 1919 when construction was started in this state on inter-state roads such as the Lincoln, Dixie, Chicago-Milwaukee, National Old Trails and Chicago-St. Louis Highways. Previous to this time the testing of road oils, asphalts, paints, creosoted wood blocks, bricks, steel and cement was accomplished by a small but efficient staff of engineers at the Highway Testing Laboratory in Springfield. The advent of construction such as the building of inter-state highways necessitated a system which would facilitate the testing of thousands of cubic yards of materials in the field. To meet this need, inspectors were placed over different sections of the highways under construction to travel back and forth inspecting the material as it arrived, and make reports each day to the Highway Testing Laboratory in Springfield. Cement was inspected at the seven mills supplying it by junior testing engineers who made their tests as soon as the material was loaded and immediately sent the reports of its acceptability to the resident engineers. During the year 1919, 299,329 yds. of sand, gravel and crushed stone and 751,489 barrels of cement were inspected with exceptionally good results.

Inspecting Aggregate

In 1920 a decided change in the method of inspecting aggregate was adopted. Inspectors instead of being placed at construction sites were located at the source of production. This system permitted the installation of inspection equipment of a more permanent nature, insuring in

some degree better facilities for making a more thorough inspection. Perhaps the greatest advantage in adopting the "production site inspection" lies in the fact that rejection of unsuitable material at construction points is eliminated and consequently a saving in time and expense is experienced by the material man, the contractor and the State. Though materials producers realize that specifications must be adhered to, the rejection of aggregates after they have been loaded and shipped to the construction site produces an irritation which does little to promote harmony in business relations. Illinois, however, was not led to make this change in system of inspection by any "good fellowship" feelings but rather by the benefits which she herself would derive. Though a slight increase in inspection cost was noted, savings along other lines more than eclipsed the added expense. A hastening of construction was apparent immediately. The materials men knew that when the car of material was shipped it would be used; the contractor knew his material passed specifications and preparations to use it immediately upon its arrival could be made without hesitancy; the State resident engineer could carry on his work without fear of hurry-up calls for inspectors and the resulting squabbles of rejections.

Under the new system, materials from 69 plants in this and neighboring states were inspected. Over 690,000 cu. yds. of sand, gravel and crushed stone passed the tests made by the inspectors. During this year inspection was carried on at nine cement plants, 1,281,537 barrels of the product being tested.

District Testing Engineers

At the beginning of the 1921 construction season an improvement was made on the already satisfactory system of inspection. District Testing Engineers—men with considerable experience in highway materials—were permanently located at district engineers' headquarters. The duties attached to this office are to supervise the work of the inspectors in the different districts and to co-operate in every respect with the district engineers in their efforts relating to materials. The testing engineers also visit construction sites, confer with contractors and see that material troubles are cleared up in a quick and efficient manner. The value of organization was truly shown when, after adjustment to the new arrangement, a remarkably smooth running inspection "machine" has resulted, which, strange as it may seem, has proven satisfactory to every one connected with the construction of Illinois highways. Inspectors are able to settle small difficulties in little time. Long and repeated correspondence has given way to the short telegram or card to the district testing engineer. The written letter was replaced by the face-to-face interview which brings far better results and leaves behind a much better feeling. District engineers are able to take up their materials troubles with one person instead of twenty. The Testing Engineer at Springfield is not called upon to settle minor troubles at a hundred places, but in conference with 9 men he controls the inspection activities at all plants furnishing materials.

During the first eight months of 1921 over 650,000 cu. yds. of aggregates were inspected for use in Illinois highways. This material came from 80 different plants in Illinois and surrounding states. Cement aggregating over 910,000 barrrels was also tested during this period of time by junior testing engineers located at 12 different mills.

Cost of Inspection

It would appear that inspection as thorough and on such a large scale as carried on by Illinois could not be economically maintained. A careful accounting of the costs of inspection during 1920 was made and, including the laboratory expense, was found to be a trifle less than 0.7 of 1 per cent of the construction costs. A slight increase is expected in 1921 but it is thought that the most liberal estimate will still keep the costs under 1 per cent of the construction expense. With inspection as efficient as maintained at present, such an expense is easily justifiable.

Inspecting Steel

The advantages of inspecting material at the source of its production was so pronounced that it was decided to attempt this method in inspecting steel. An inspector was stationed in Chicago early in the spring of 1921 and the results of his work were gratifying to such an extent that the Department maintained this system of inspection throughout the year, and intends to continue it in the future. Mill operators as well as contractors are particularly pleased with the present system, and difficulties have apparently ceased in the inspection of this type of construction materials.

The Making of an Inspector

The success of Illinois inspection system is based, in a great measure, upon the type of inspector and the training he has had and gets before he is sent in the

field. Technically trained men make up the greater part of the field force, but whether these men are engineers or not they must have one qualification which has proven to be essential to the success of an inspector—personality. At its best, inspection work is of a nerve-trying nature with the materials men at the disadvantageous position. To be able to reject material and still "get along" with the men in charge is a characteristic which an inspector in the Bureau of Tests of Illinois must possess.

In spite of what engineering development a man may have had, when he comes to this Department he must go through a regular course of training before he is placed on a job. This training occupies a week and is carried out in the Laboratory at Springfield. A thorough course of inspection involving difficulties which may come up in the field, laboratory and construction site, is given each prospective inspector. A knowledge of the system of records is also required, as well as the making up of daily reports. After the course of training has been completed, a rigid examination, which includes the various phases of inspection work, is given the candidate. A passing grade must be obtained before any person is retained as an inspector. When a new inspector goes into the field, the district testing engineer stays with him until he is quite familiar with the work.

Testing Aggregates

In testing aggregates at the plants, samples of the material are taken from each car to be shipped. These samples are given a mechanical analysis, a silt analysis and a visual inspection. The mechanical analysis, made with standard screens, determines the gradation of the aggregates. The visual inspection is made for the purpose of "spotting" shale, shells and other soft material. Each inspector is required to send in to the main office a daily report on material inspected and shipped. The report contains the results of the tests made, the quantity of the material shipped, the source of its production and the contractor to whom the material is consigned. These reports are made up in triplicate form; one to go to the main office, one to the district engineer and the third to the resident engineer of the section to which the material is consigned. Upon receipt of the report the resident engineer fills out that portion of the report which pertains to the section number, the county and the route where the material is to be used.

Working in conjunction with the field force of inspectors is the testing department of the laboratory at Springfield. Previous to the placing of the proper equipment at production points and the locating of inspectors at these places, the laboratory was called upon to test all material of which there was the slightest doubt. Under the new system only special cases of testing are handled in the laboratory. At the opening of any new sand or gravel pit, stone quarry, or cement mill which is to furnish material for Illinois highways, samples of the product are thoroughly tested in the laboratory. Also at the beginning and at the end of each construction season, samples from all plants which supplied material during the year are given "quality tests." These tests, in the case of sand and gravel, include sieve analysis, washing, wearing qualities, organic material content, and other standard tests. Rock is tested for wear, specific gravity, absorption, hardness, toughness and cementation value. Cement is given a chemical test, besides tests for soundness, time of set, fineness and tensile strength. All tests are kept in a permanent record book, and serve as checks on the quality of material produced.

A DRAINAGE EXPERT'S IDEAS ON HIGHWAY CONSTRUCTION

By Edgar A. Rossiter, Consulting Civil Engineer, 127 N. Dearborn St., Chicago, Ill.

(Editor's Note: Our contributor here makes a forceful presentation of a recommended revision of highway drainage practice. He joins us in the hope that this article, written in a spirit of constructive criticism, will lead to an interesting and helpful discussion.)

Our technical papers, books and magazines for the last ten years have been filled with articles relative to Highway Construction, and inasmuch as there will be more money spent in the construction of roads during the coming decade than in any other form of construction, a complete understanding and enlightenment of the subject is desirable and of the utmost importance.

To the layman many of these articles are but a pitiful confession of ignorance of highway construction by their authors. Even the professor sometimes holds up his hands in humble supplication to be free from the machinations of the politicians and his prayer for a million dollars for research and experiment is an excruciat-

ing and painful acknowledgment of his lack of knowledge and vindication of the politician's lack of faith in his ability or recommendations.

Approximately eight hundred million dollars is in sight and available for state, county and federal highway construction. Is there not one master mind of construction, not one eminent highway engineer, who can step to the front and fill our pages with how to build and to build right?

A certain highway engineer said that we could not tell him anything about building roads as he had been engaged in that business for 25 years, but when asked if he could show one single mile of road that he was especially proud of in his territory, he had to admit that he could not. How many others can? Is it not true that, "By their works ye shall know them?" If battleships were made in the same manner as some highways they would crush in with their own weight; if skyscrapers were built in a like manner many would not survive to be roofed; if engines were to be designed with as little knowledge of the subject matter as highways are constructed heaven knows what they would or would not do.

The Naval Architect, the Structural Engineer, the Mechanical Engineer need no apology when in the design of their work they include a question of foundation and a study of all the elements entering into the making and use thereof. The railroad engineer years ago discovered that foundations were the essence of travel and he did not hesitate to change his plans as each class of soil was reached. The drainage engineer at one time tried only to drain the low lands, but as his knowledge broadened, he found that the high lands contained pockets of water-bearing sand, and syncline basins, filled with water, were encountered even in the foothills and higher lands.

As the sub-soils govern the foundation of the buildings and other structures whose footings reach below the frost line and often reach to rock, is it not only reasonable to expect that the Highway Engineer should take into consideration every element that enters into good road construction and wherever possible prepare his foundation to a point below the frost line?

An eminent authority writes, "Our pavements float above the frost line, often on a sea of mud whose strength or behavior we know nothing about and in addition we are compelled to shave close to ultimate strength," and yet we place eight hundred million dollars in the hands of such men to construct highways. If men know these facts and yet do not have the moral courage of their convictions and knowledge to shout them out to the world, what must we expect of the politician or farmer roadmaster to whom their recommendations are submitted?

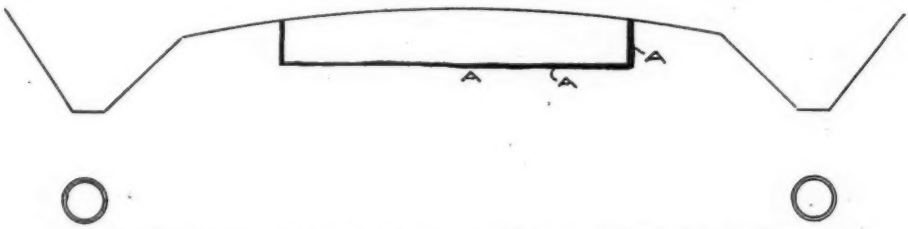


FIG. 1: COMMON TYPE OF ROAD DRAINAGE CONSIDERED FAULTY BY DRAINAGE EXPERT.

The Figure Indicates an 18 ft. Concrete Roadway, with 6 ft. Built-Up Shoulders and Side Ditches 2 or 3 ft. Deep. The Tile Drains Shown Would be as Serviceable if on the Telephone Poles as in the Position here Indicated, in the Opinion of the Author. The Shading Indicates the Capillary Movement of Water on the Subgrade.

Highway engineers have been very profuse in the assertion that the causes of various cracks in concrete pavements are unknown, but let us reason from the standpoint of the Drainage Engineer, Elliott in his treatise on drainage, labels water as Hydrostatic and Capillary. And it is a drainage axiom that dry material, when frozen, does not heave, swell or shrink; therefore, let us take the average 18 ft. concrete roadway, with built-up 6 ft. shoulders, with a 2 to 3 ft. ditch, to drain the roadway as shown in Fig. 1.

What is the resultant of storm forces on such a plan? The heavy storm water which pours down in torrents, runs off over the pavement and shoulders and passes away in the drains and ditches we will call the hydrostatic water. It does no special harm. But what becomes of the capillary water, the slow running water that slides over the pavement, with no special velocity and drips down along

the edges of the concrete and soaks under the concrete; even follows the line of the concrete over the well rolled subbas, at first possibly only for a few inches, but gradually at each succeeding shower until quite an area is covered? See Fig. 2. What happens?

It is quite evident that it will begin to puddle and settle every time a team or truck passes over it until a truck will pass, whose weight is equal to the tensile strength of a certain line of concrete when the break will occur. The break

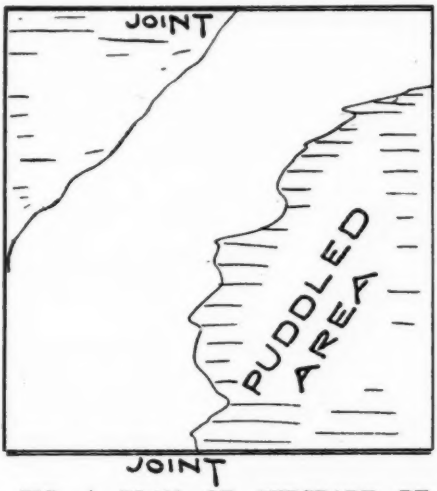


FIG. 2. PLAN OF SUBGRADE BETWEEN TRANSVERSE JOINTS SHOWING PUDDLED AREA DUE TO SEEPAGE OF CAPILLARY WATER BETWEEN PAVEMENT SLAB AND SUBGRADE.

need not follow the line of the puddle but will travel in the line of least resistance. During the construction and after the rolling you will find that all the hauling has been done in the center of the 18-ft. space and generally the subgrade is lower than the edge which gives the capillary water a good chance to flow to the center of the road; this water settles the sub-grade, leaving the slab unsupported.

In Fig. 1, drain pipes are shown which might as well be on the telegraph poles as far as any good the concrete pavement will derive from them; but this is the way some highway engineers have "doped" it out. Quite frequently the cut for the sub-grade is made leaving the finished pavement between two shoulders of native soil which again aids the capillary water in undermining the finished work.

Then, again, in the grades over a hill sometimes even on fairly steep grades the Highway Engineer will say, "There is no need of drainage." But the Drainage Engineer has learned the meaning of impervious soils and he knows that beyond such walls, pockets of quick-sand or rather, floating sands, puddles of plastic clay, are to be found. These impervious soils form syncline basins, sometimes reaching through subterraneous channels for thousands of feet and through these channels are drained the catchment area of many acres of land and the drainage engineer will tell you that even the hillsides need drainage.

Some departments have done away with the expansion joint, claiming that the concrete will crack anyway so let it crack where it will. If we eliminate the cracks due to the lack of drainage and puddling of slabs, then assume that we build a continuous slab for one mile and fasten the ends so that it can not move, what happens at a drop in the temperature of 50 to 60 degs. (friction not considered)? Will it take a mathematical expert to tell us that the forces of nature will break the slab, as often as the tensile strength of the concrete is equal to the weight of a certain section of the slab and that we will have as many cracks as the total weight is divisible by the tensile strength of a cross section of the slab and that we will have about 157 cracks per mile? Did it ever occur to the engineer that when that great force is exerting its strength to the ultimate breaking point that it is weakening every foot of the pavement subject to such a stress?

The stability of pavements depends on "how firm a foundation" and most highway engineers, like the old colored preacher, are satisfied to leave it to the Lord. If it is true that dry material will not expand, shrink or swell when frozen, then it is a simple question of obtaining a dry foundation down to a frost line. This can be obtained by laying lines of tile on the outer edges of the 18-ft. roadway and filling the trench with the same material, then by rolling the space between the drains to an unyielding surface. I would even slightly curve the sub-grade. Did it ever occur to the highway engineer to form a drip under the edge of the concrete to lead the water down the drain instead of under the concrete? See Fig. 3. These drips are constructed in every window sill or water table, and would it not be advisable to adopt them in road making?

My attention was called to a mile of concrete pavement having expansion joints and the report was that there was not a single crack for one mile. I know the location. The concrete was built on

sand, which gave an unyielding foundation, perfect drainage and a cushion. Nature has provided what engineers must supply where good roads are to be built.

If a concrete road built on sand gives an unyielding base by reason of the drainage afforded, eliminates the upheaving of the work, and forms a cushion, are they not the elements that are inductive to good road-making? We drift back to the axiom that dry material, in freezing does not swell, shrink or expand and if our sub-base is constructed with these elements we will have good roads.

If we can eliminated puddling and a shifting sub-grade by good drainage, so that the foundation can carry a uniformly distributed load or even a shifting load without cantilever action, or beam stresses, and then place expansion joints within the elastic limits of the concrete, does the highway engineer suppose that we would have the cracking that now takes place? Would not such construction reduce cracks to 10 or 15 per mile instead of the prevalent 150 to 180?

For some reason State Specifications are generally alike throughout an entire state, no matter whether the road passes through rocky hills or through swamps and low lands. No private enterprise would entertain such a condition. Specifications should be adapted to meet the local conditions and foundations should be prepared to the end that the wearing surface could carry the load. In some cases special foundations should be constructed and used for a year or two before the finish surfaces are placed; drainage and foundation requirements apply whether the road be built of concrete or any other material.

When Highway Engineers are in a position to tell the public how to build good roads, public opinion will demand that the best be constructed. There is a way to construct good lasting roads but they cost money.

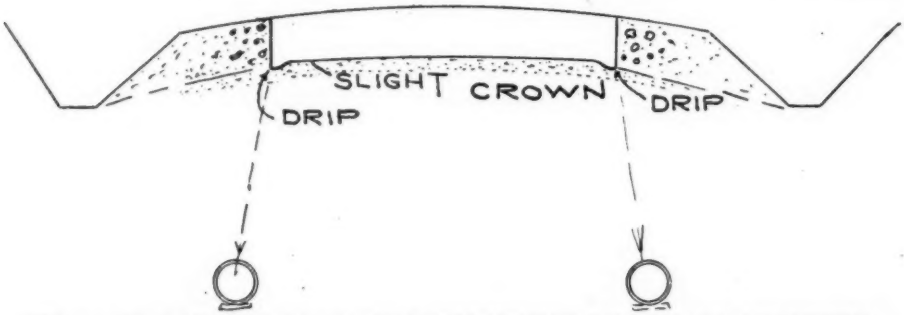


FIG. 3. TYPE OF ROAD DRAINAGE RECOMMENDED BY A DRAINAGE EXPERT.
The Lines of Tile are Placed at Outer Edges of Roadway; Space Between Trenches is Rolled to an Unyielding Surface; Subgrade Slightly Curved; Drip is Formed Under Edge of Concrete Slab to Lead Water into Drains Instead of Under the Concrete.

CONSTRUCTING KENTUCKY ROCK ASPHALT PAVEMENT ON DIXIE HIGHWAY BETWEEN LOUISVILLE AND WEST POINT, KENTUCKY

By J. H. Cahill, Contractor, Louisville, Ky.

The completion of the Dixie Highway from Louisville to Camp Henry Knox, at West Point, Ky., has been a matter of great satisfaction, not only to Kentuckians, but to thousands of tourists. This highway is really the gateway to the South, carrying almost all the automobile traffic from the upper Mississippi Valley. Probably no road south of the Ohio river is subjected to such heavy traffic.

The section just completed is a macadam base with a Kentucky rock asphalt surface, and replaces an old macadam road constructed several decades ago. The improvement begins about 8 miles from the city limits of Louisville, the terminus of the rock asphalt section constructed in 1915-16, and extends for a distance of approximately 11 miles.

The old macadam road, as originally constructed, consisted of a first course of sandstone and soft limestone broken to a size of about 6 ins. Over this was placed a course of broken limestone and clay, the surface being leveled and compacted by traffic.

When the road was originally constructed, very little attention was given to line and grade. It was, therefore, necessary to relocate the road in several places and lay a smooth grade line. The old road was subjected to overflow for a distance of about 2 miles near West Point.

SECTION OF ELEVEN-MILE EXTENSION OF DIXIE HIGHWAY WITH KENTUCKY ROCK ASPHALT SURFACE AS DESCRIBED IN THIS ARTICLE.

This necessitated the building of a high fill, which it is believed will place the new surface above all except extraordinary high water, such as that experienced in 1913.

The new grade was laid so that the old stone base could be used as much as possible. Owing to the fact that very fine stone, dust and earth compose as much as one-half of the base, the thickness was measured every few hundred feet and the effective depth considered equal to 50 per cent. of the measured depth. Sufficient stone was then added to make the total compacted thickness of the base 9 ins. The old surface was only 16 ft. wide. The new surface is 20 ft. in width. The old surface was scarified and shaped to 20 ft., the extra 4 ft. being added on one side only. Stakes were set to enable the contractor to get the proper grade and cross-section, and stone from the old surface was moved to the extra 4 ft. in sufficient quantity so that after compacting the entire 20 ft. would be covered with the same depth of old metal. Shoulders were then thrown up by excavating along the sides. Shoulder drains were constructed of broken stone at all low places in the road.

The first course was built a total depth of 7 ins. compacted, sufficient new stone being added so that when combined with the stone in the old base, it would equal 7 ins. All stone used in this course passed a 3½-in. screen and was retained on a ¾-in. screen. Trucks equipped with an end dumping device were approved as a satisfactory means of spreading stone. Stakes were set at a sufficient number of points across the road and the contractor spread the stone loose to the top of the

VIEW ON DIXIE HIGHWAY JUST SOUTH OF LOUISVILLE, KY. KENTUCKY ROCK ASPHALT ON OLD MACADAM BASE LAID IN 1915-16. PHOTOGRAPHED DECEMBER, 1921. THIS ROAD CARRIED 4,000 VEHICLES A DAY, MOST OF THEM ARMY TRUCKS, DURING THE WAR.

stakes. Two or three men with stone rakes smoothed the stone surface, after which it was lightly rolled, and screenings, ranging in size from ¾ in. to dust, were spread over the base and each layer rolled dry. This process was continued until the screenings were flush with and not above the top of the rolled stone. The surface was then thoroughly wet and rolled at the same time, sprinkling and rolling being continued and additional screenings added, where neecssary, until all voids were filled and the metal well bonded. No excess screenings were allowed on top of the surface, the aim being to leave the screenings slightly below the surface to provide anchorage for the second course.

The top course was built a thickness of 2 ins. compacted. Stone for this course was required to pass a 3½-in. screen and be retained on a 1½-in. screen. Stakes were set at the edges, quarter points and the center every 25 ft. along the road. The contractor spread the stone to the top of the stakes. This stone was spread from trucks and leveled by hand, using stone rakes. The stone in this course was thoroughly rolled, but no screenings were applied, the voids being left open to afford good anchorage for the rock asphalt.

After the second course was completed,

TYPICAL APPEARANCE OF TOP COURSE OF STONE SHOWING VOIDS LEFT OPEN TO GIVE ANCHORAGE FOR ROCK ASPHALT.

edge boards were set to line and grade and Kentucky rock asphalt spread over the stone base. The asphalt was hauled in trucks and dumped on planks placed on the second course. The asphalt was spread by hand from the dumping board, carefully raked and finally smoothed by

DUMPING ROCK ASPHALT ON BOARDS WHICH ARE MOVED FORWARD WITH THE PROGRESS OF THE WORK.

the use of a template. The material near the edge boards was tamped down, the edge boards removed and the earth shoulders placed against the asphalt. The entire surface was then rolled, the rear wheel of the roller overlapping the shoulder about 6 ins. The first rolling consisted merely in passing over the asphalt once with a 10-ton 3-wheel roller. The second day it was rolled three or four times and the third day rolled as much as thought necessary and then cross-rolled with a 5-ton tandem, to remove any small waves and marks from the roller wheels. This type of surfacing gives a good wearing surface above the stone, and, in addition, all voids in the open stone base are filled for a depth of about 2 ins.

The writer, who was the contractor on the work, made some records in constructing the surface which are considered extraordinary. On June 16, 1921, the crew of 16 men laid 1,275 lin. ft. of Kentucky rock asphalt in 10 hours. This crew consisted of 4 rakers, 5 forkers, 4 men who handled the dumping boards and 3 men to place the edge boards. As the haul to the asphalt storage was short, one truck handled all the material.

The Kentucky rock asphalt used for surface was produced in Edmonson County, by the Kentucky Rock Asphalt Company, of Louisville. It is quarried and

crushed in a similar manner to ordinary limestone; pulverized to about the consistency of coarse meal; loaded in barges at the plant and towed about 70 miles to Bowling Green, the railroad terminal. It is then loaded in open-top cars and shipped, ready to lay cold.

For unloading the asphalt, we used a Byers Auto Crane equipped with a ¾-yd. clamshell bucket. Owing to the car shortage, several cars were unloaded and stored before the actual work of construction was undertaken. This method insured material constantly on hand, and it was found that the material was easy to handle from the storage piles.

In order to place the road above high water, it was necessary to build a heavy earth fill as high as 25 ft., in some places. This fill, with the extra material moved to allow people living along the road to reach the new road, totaled 242,000 cu. yds. The fill was built with a Marion Drag Line, equipped with a 2-cu. yd. bucket. Owing to the fact that the fill was not rolled or otherwise compacted, 25 per cent. was allowed for shrinkage. A water-bound macadam surface was placed over the fill, no attempt being made to lay the rock asphalt until the fill has thoroughly settled and compacted.

CONSTRUCTING STANDARD TYPES OF ASPHALT PAVEMENTS

By W. L. Hempelmann, Engineer, Asphalt Sales Department, The Texas Co., 10 S. LaSalle St., Chicago, Ill.

Asphalt materials find a use in many other types than those commonly included under the name of asphalt pavements, and such other wearing surfaces often depend upon the proper functioning of an asphalt material in obtaining a satisfactory pavement. We all know how important the proper filler and expansion joints in a concrete, wood block or brick pavement become when climatic changes bring corresponding changes in such surfaces, the rupture or destruction of which may depend upon the asphalt material doing its part. Carrying the analysis a little further, we find that the country becomes more and more desirable and inviting as the dust on such connecting highways, for the most part not permanently improved, is reduced to a minimum by proper treatment with an asphaltic product.

Not including surface treatments of any kind, asphalt pavements can be divided into three types, namely, Asphalt or Penetration Macadam, Asphaltic Concrete and Sheet Asphalt. All are produced by combining an asphaltic material in certain proportions with various graded aggregates, either on the job or in specially designed plants.

An Asphalt Macadam roadway consists of a base of suitable thickness, such as Telford, broken stone, etc., and the construction thereon of a penetration macadam wearing surface. Such base should be 6 to 9 ins. thick, thoroughly compacted on a thoroughly rolled and drained subgrade. Drainage has been preached so long that every one knows the importance of this very important good roads item, and practically all the experience on any type of road applies equally well to all other types under similar conditions, due allowance being made for the difference in the wearing surface.

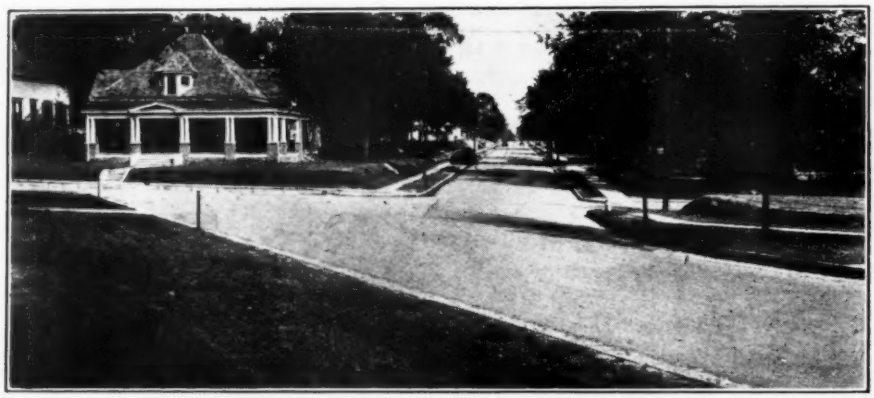
BRICK PAVEMENT WITH ASPHALT FILLER ON MAIN STREET, GALESBURG, ILLINOIS, AFTER SIX YEARS' SERVICE.

GRAVELLED BUSINESS STREET IN SAN MARCOS, TEXAS, TREATED WITH LIGHT ASPHALTIC ROAD OIL, AFTER THREE YEARS' SERVICE.

Type I—Asphalt Macadam

To a large extent the success of an asphaltic macadam pavement depends upon the stability of a thoroughly rolled and bonded base. Over the properly prepared base screened broken stone is spread to a depth of from 2½ ins. to 3 ins. after compression. This wearing surface stone should be tough, hard, durable and free from surface stone, from 1½ ins. to 2½ ins. in size and substantially free from dust. Stone of uniform size and wearing qualities is absolutely necessary for the construction of a satisfactory wearing surface. Everything else being equal, the harder the stone the better the surface, but soft stone has been used in a fairly successful pavement, though results obtained with combinations of the two usually proved unsatisfactory. Prior to the application of the asphalt binder, the wearing course of stone should show a uniform open surface. Mechanical pressure distributors are to be preferred for applying the asphalt binder, though many miles of successful penetration macadam have been poured with hand-pouring pots. As nearly as possible, every square yard of surface should receive the same amount of bituminous material, which will depend on the grading inch of depth of wearing surface. After application, no stone should be visible. The temperature at which the binder is applied will vary with the nature of the material used, and in any case it must be very liquid to find its way to the bottom of the wearing surface before congealing. For best results the stone should be clean and dry and the atmospheric temperature high.

Immediately after applying the binder, dry, clean durable stone chips, varying in size from ¼ to ¾ ins., should be spread evenly over the surface and then rolled. The rolling intended to force these smaller stone particles down and between the wearing course stone and in a manner strengthen the mechanical "keying" of the stone. Such surface should show stability under the roller and not wave. After rolling, the surface should be thoroughly swept until free of all surplus fine



ASPHALTIC CONCRETE PAVEMENT ON HICKORY STREET, TEXARKANA, ARK.

mineral and the seal coat of asphaltic material applied, which will vary from ¼ to ¾ gals. per sq. yd. of surface. Stone chips as above are then evenly spread over the surface and rolled, after which the roadway may be thrown open to traffic. Where local durable stone is available this is one of the most satisfactory and moderate priced pavements.

Again this is a very popular method for resurfacing old macadam highways where the depth of such macadam is sufficient to form a satisfactory base, requiring only 2½ to 3 ins. of penetrated stone for a practically new pavement. Resurfacing old macadam is recognized as a type by the American Society for Municipal Improvements whose standard paving specifications are well known in the highway building field.

In the penetration macadam pavement we aim to build a dense stone and asphaltic wearing surface, in which every particle is thoroughly coated and in which all particles large and small are held in place by a satisfactory asphaltic binder.

The fact that satisfactory penetration macadam pavements can be constructed without expensive equipment and with a corresponding lesser overhead charge, makes this type of construction very popular with the smaller contractors and in communities where the roads are not subject to excessively heavy traffic. For the small jobs a melting kettle and a pouring can constitute the added equipment.

Type II—Asphaltic Concrete

Asphaltic concrete represents the next higher type of asphaltic construction. As the name implies this represents a mixture of coarse and fine aggregates cemented and held together by a suitable asphaltic cement. This in the main requires a specially designed plant capable of heating and combining stone, sand, mineral dust and asphalt in definite and fixed proportions, the hot mixture being conveyed to the job by motor trucks or wagons, when it is dumped, spread, raked and rolled to the required depth on a suitably prepared base. Tough, durable stone, as nearly cubical in shape as possible, should be used. To this is added fine stone, and mineral dust, varying in size from impalpable powder upwards and all particles, large and small, are coated with a film of asphalt of substantial thickness. Proportioning of the ingredients is done by weighing, the temperatures being under thermometer control. By proper proportioning of the ingredients a dense, practically voidless mass is obtained when this hot mixture is compressed by the roller on a suitable base. Hot mixed asphaltic concretes have been used for many years, the most popular type today being known as the Topeka Mix, because of a coarse mineral aggregate pavement laid about ten years ago in the city of Topeka, Kas., by the Kaw Paving Company. Asphaltic concrete pavements are in use under all kinds of traffic and climatic conditions, and giving satisfactory service. This moderately priced pavement represents one of the most economical types, and may be laid over old macadam or Portland cement, or asphaltic concrete, as a base. The consistency of the asphalt used will depend upon the climatic conditions, and the nature of the traffic.

In general three methods are employed to make a hard pavement: first, by the use of a hard asphaltic cement; second, by a high per cent of 200 material, and third, both hard asphaltic cement and high per cent of filler.

All bituminous pavements, as well as all others, are influenced by temperature changes, only in a different way. Proper grading of the aggregate held together by an asphaltic cement not seriously affected by temperature changes gives the required stability to such mixture. In every case the desirable pavement is one which will be hard enough not to crack by contraction during the winter. This property is furnished in the main by a suitable asphalt. The average Topeka mix closely resembles a sheet asphalt mixture to which approximately 25 per cent of fine stone has been added, the stone serving the double purposes of hardening the mixture and lessening the cost. Because of the stability of this mixture produced by the stone, the binder course is required under this wearing surface as is the case with the standard sheet asphalt type of construction. The above features have resulted in producing a wearing surface, the cost of which is so moderate and the serviceability so great that it has become and will remain one of the most popular pavements for city streets and highways.

Old macadam roads, of substantial thickness, but in need of repair, have been very successfully and economically resurfaced with asphaltic concrete wearing surface. It easily represents the most economical hard surface pavement applicable in the resurfacing of old macadam, worn out block, and concrete pavements. By strict attention to essential details in construction, holes, cracks, raveled areas, etc., in old pavements can be initially repaired with asphaltic concrete, prior to

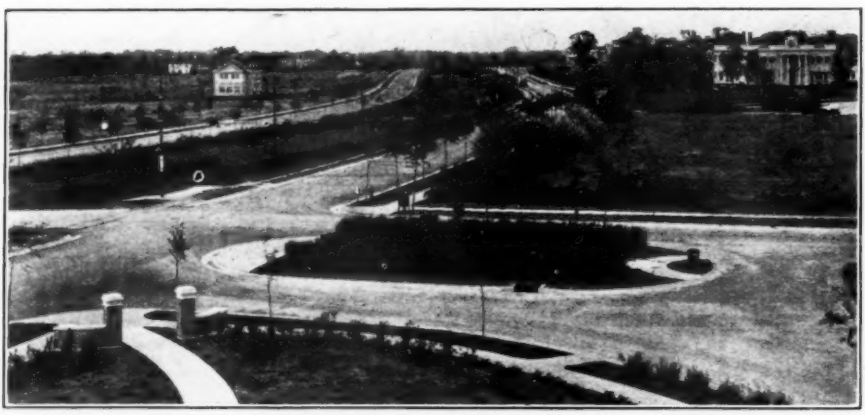
SHEET ASPHALT PAVEMENT ON NORTH FIFTH STREET, READING, PA.

applying the uniform wearing surface layer.

Just a word about foundation surfaces under asphalt pavements. Contrary to the practice of surfacing the foundation under all unit pavement construction, such as brick or block, we advocate a rough concrete surface under asphalt pavements, this because of the "keying" effect of such surface on the superimposed asphalt mixture. The roughness of such surface should be obtained by projections of part of the coarse aggregate in the concrete and not by any attempt at roughening the surface of the green concrete by the use of lug-tampers or other similar devices. Any small impressions in the concrete will be filled in the brooming of the surface prior to laying the asphaltic concrete and hence will prove valueless in anchoring such wearing surface.

Type III—Sheet Asphalt

Sheet asphalt, the standard asphalt pavement, represents the higher type of asphalt construction. Under all kinds of traffic and climatic conditions it has demonstrated by long years of service that it is one of the most satisfactory pavements ever developed. Intrinsic merit alone has permitted this type of construction to live and increase in popularity from year to year. As usually constructed this type of pavement consists of an asphaltic concrete binder course of from 1 to 2 ins. in thickness over which is laid a sheet asphalt wearing surface of 1½ to 2 ins. thick. "Close" binder strongly resembles asphaltic concrete, though no attempt is made to include a filler, while the "top" or wearing surface consists of particles all passing ¼-in. screen. Sheet asphalt pavements, their composition, method of preparation, etc., are all so well known to all who have looked into the pavement question that these features need not be discussed here. There are, however, one or two points worthy of consideration.



ASPHALT MACADAM PAVEMENT ON HARD PARKWAY, KANSAS CITY, MO., AFTER FOUR YEARS' SERVICE.

Without question, properly constructed sheet asphalt pavements are heavy traffic pavements. Long service tests in some cases extending over nearly half a century must be considered as conclusive evidence of the merits of this construction. Fifth avenue in New York, surely a beautiful street, and said to carry the heaviest traffic in the world, is paved with sheet asphalt.

The country highways today are being called upon to carry traffic which in many cases approach that which is carried by city streets. Surely a material which by service tests has proven its suitability as a paving material for city streets, will be suitable for country highways. Paving statistics show in 1915, 61 per cent of all paving yardage laid in the municipalities of the United States was of the higher type of asphaltic pavement construction. Similarly in 1916, 60.7 per cent of the yardage was asphaltic, and in 1917, 64.2 per cent represented the asphalt pavement percentage. In other words, over a period of three years, more than three-fifths of the total municipal paving yardage was of the higher type of asphaltic pavement construction. In Chicago, out of a total of 132 miles of pavement constructed in 1917, 104½ miles, approximately 80 per cent was of asphaltic construction.

For heavy city traffic undoubtedly standard sheet asphalt is a most satisfactory and economical pavement. On through country highways properly constructed "Topeka Mix" asphaltic concrete is to be recommended. In building roads or pavements we build for permanence and on a properly constructed base sheet asphalt or asphaltic concrete pavements represent types most economically maintained over long periods.

There must be and are good, logical reasons why statistics, from sources which have to deal with traffic conditions much more severe than country highways will be called upon to meet, show a general use of asphalt pavements. The principal reason is that properly constructed asphalt pavements subjected to the test of every class of traffic have demonstrated their serviceability.

They are largely composed of local material, they are smooth, noiseless, sanitary and attractive in appearance, have a low tractive resistance, and are easily repaired. Their first cost is moderate, cost of permanent maintenance is low, they lessen cost of vehicular upkeep and they are durable.

DENSE ASPHALT CONCRETE PAVEMENT SPECIFICATIONS

By J. W. Howard, C. E., E. M., Consulting Engineer on Construction and Testing of Roads and Pavements, 1 Broadway, New York; Laboratory at 234 Mt. Prospect Ave., Newark, N. J.

Municipal and County Engineering has honored me with a request to prepare a contribution which may be of practical use to cities, counties and states. The following specifications for a dense asphalt concrete pavement or road, set forth in detail what the writer believes to be the best requirements for materials and construction of this type. They are based on experience of many years, and when strictly enforced, a very durable pavement of this kind is obtained; one which is closer, denser, more water-proof and more durable than the necessarily porous and unstable ones having the Topeka and similar mixtures.

General Requirements

(1) The stone used in the binder and pavement surface layer shall be hard, tough, clean, well shaped crushed trap rock or equally good granitoid rock, silicious limestone (or hard flintic gravel) acceptable to the engineer. All stone (or gravel) must be clean, free from soft particles, clay, dust and foreign matter.

(2) The sand used in the binder and surface layer shall be clean, hard grained, moderately sharp and free from clay.

(3) The powdered mineral filler of the mineral aggregate of the asphalt concrete pavement mixture shall be powdered limestone or other suitable mineral. Seventy (70) per cent of the filler shall pass a 200-mesh sieve.

(4) The asphalt cement for the binder and surface layer of the pavement, shall have the following qualities and meet the following tests which are made by standard methods of the A. S. M. I. and A. S. T. M. and as stated below. (a) It must contain no water, coal or gas tar product. (b) It must be homogeneous and uniform. (c) It must not be injured by water or contain matter which prevents it being waterproof. (d) It must be ductile at 77 deg. Fahr. so as to be stretched at least 40 centimeters. (e) Its specific gravity at 77 deg. Fahr. must be at least (1) one. (f) Its penetration or degree of softness at 77 deg. Fahr. must be between 35 (0.35 cm.) and 50 (0.50 cm.) according to the temperature of the local climate, also the weight of the traffic, low for heavy and higher penetration for light traffic. (g) Its freedom from

volatile oils and safety for heating for use, must be tested by the open flash test; made with the asphalt cement in an open container about 3 ins. in diameter and about 2½ ins. deep, with the thermometer bulb in the melted asphalt-cement. The flash point must not be below 400 deg. F. (h) Its stability against injury by heat in use and by weather action on the pavement is determined by exposing 50 grams in an open tin can 2¼ ins. diameter, 1½ ins. deep, 5 hours, in hot oven air, at 325 deg. F., and must not lose more than 3 per cent of its original weight. (i) The penetration or degree of softness of the residue at 77 deg. F., after test (h) must be at least 60 per cent of its original penetration test (f); that is, test (h) must not harden it more than 40 per cent. (j) The purity or pure bitumen content of the asphalt-cement used in any one pavement, determined by solubility in carbon bisulphide, must not vary more than ½ of 1 per cent up or down. (k) At least 99 per cent of the pure bitumen of the asphalt-cement must be soluble in carbon tetrachloride at about 77 deg. F. (l) The asphalt-cement must have an average cementing strength (three tests) of at least 25 lbs. per sq. in. (Howard or like method), when made into a hot and fully compressed briquette composed of standard Ottawa sand (20-30 mesh size grains), 90 parts by weight and 10 parts of the approximately pure bitumen of the asphalt-cement (or asphalt-cement itself when above 99 per cent pure bitumen). These briquettes have the same shape and size as the standard Portland cement briquettes of the Am. Soc. C. E. and must be broken by tension at 77 deg. F. in any briquette cement-testing apparatus used for Portland cement tensile tests.

(5) The measuring of the proportions of the various materials specified for use in binder, and the pavement surface layer mixtures, must be done by weight for each box or batch, and the pavement mixing plant must be equipped with a permanent visible weighing device attached to the asphalt-cement measuring bucket, also a separate weighing device attached to the mineral aggregate measuring box.

(6) Vertical contact surfaces of gutters, curbs, manholes, etc., shall be well painted with asphalt-cement before the binder and wearing surface are laid. The binder and pavement next to all curbs, crosswalks, basin heads and the like shall be firmly rammed with hot rammers.

Dense Asphalt Concrete Pavement Preparation and Laying

(7) The asphalt-concrete pavement shall consist of an asphalt binder layer, laid on the finished foundation of the kind specified, and a dense asphalt-concrete wearing surface layer on the binder with a seal coat on its surface. The thicknesses of these finished two layers shall be: binder one (1) inch thick at all points, and asphalt-concrete surface layer one and one-half (1½) inches thick at all points. A slight excess of thickness of binder and surface layer is required and permitted to even up slight inequalities, if any, on the foundation or the binder layer.

(8) *Binder Layer.* The binder shall be composed of crushed stone (or gravel), sand and asphalt-cement.

(9) Preparation and laying of the binder shall be as follows: It shall be composed of crushed stone (or gravel), sand to fill the voids in the stone and enough asphalt-cement thoroughly to coat the mineral aggregate without an excess of the cement when thoroughly compressed. It shall be a firm, dense, close, binder. The analysis of the binder composition shall be as follows (by weight):

Bitumen soluble in carbon bisulphide, 4 to 7 per cent; passing No. 10 sieve, 15 to 30 per cent; passing No. ½-in. sieve retained on No. 10, 20 to 50 per cent; passing No. ¾-in. sieve retained on No. ½, 15 to 65 per cent.

(10) The stone (or gravel) sand and the asphalt-cement, heated separately to a temperature of 225 to 325 deg. F., shall be thoroughly mixed by machinery so as to produce a homogenous mixture in which all particles of the mineral aggregate are thoroughly coated with the asphalt cement.

(11) The binder shall be brought to the work in vehicles suitably covered, and delivered upon the roadway at 225 to 325 deg. F.

The temperature of the binder within these limits shall be regulated according to the temperature of the atmosphere and the working of the binder. The binder shall be dumped upon the foundation back of where it is to be laid, deposited in place with hot shovels, then uniformly spread with hot iron rakes and at once thoroughly compacted by a roller weighing at least seven (7) tons and by tamping in places that cannot be properly compacted by rolling. The surface of the completed binder course shall be parallel with and one and one-half (1½) inches

below the finished grade and crown for the pavement. Any binder which shows an excess of asphalt-cement after compression, lack of bond, or is in any way defective or becomes broken up before being covered with the wearing surface, shall be taken up and replaced with new good binder. The finished binder shall be kept clean and free from traffic, and if necessary it shall be thoroughly cleaned by sweeping just before the wearing course is laid. No binder shall be laid when in the opinion of the Engineer the weather conditions are unsuitable, and only when the foundation is clean, free from frost, hard and dry. The surface of the roller can be only slightly moistened without excess of water while rolling the binder.

(12) *Dense Asphalt Concrete Surface Layer.* The asphalt concrete wearing surface layer shall be composed of crushed stone (or gravel), sand, powdered mineral filler and asphalt-cement, all of the kinds and qualities specified for stone, gravel, sand, filler and asphalt cement. The asphalt-concrete pavement composition shall be made by first thoroughly mixing the pre-heated crushed stone (or gravel) and sand with the limestone powder (not pre-heated) in a suitable mechanical apparatus, and then adding the hot liquified asphalt-cement, so the result will be a uniform, homogeneous mixture, which by analysis and tests will be within the following limits (by weight):

Bitumen extracted with carbon-bisulphide.....8% to 10%
Mineral passing 200-mesh sieve including 200 and finer mineral.....7% to 10%
Mineral passing 80-mesh sieve and retained on 200-mesh sieve...10% to 16%
Mineral passing 40-mesh sieve and retained on 80-mesh sieve....15% to 25%
Mineral passing 10-mesh sieve and retained on 40-mesh sieve.....8% to 23%
Mineral passing 4-mesh sieve and retained on 10-mesh sieve.....11% to 22%
Mineral passing 2-mesh sieve and retained on 4-mesh sieve.....8% to 18%

(13) The combined one-fourth (¼) and one-half (½) inch mesh mineral must be at least 25 per cent, and at least seven (7) per cent of the mixture shall pass 200-mesh sieve, and the proportions of the ingredients used must give the densest compressed mineral aggregate (exclusive of bitumen) with lowest voids possible substantially within the limits of the above percentages by analysis, and such as will make the completed pavement composition compressible to a density (specific gravity) of at least 80 per cent of the specific gravity of the stone itself used in its aggregate. The per cent of bitumen shall be strictly within the limits above specified and sufficient thoroughly to coat all the particles of the mineral aggregate and produce a pavement not too soft in summer or brittle in winter; the intent being a close, dense, waterproof pavement. The fully compressed asphalt-concrete pavement must have a density or specific gravity of at least about 2.30.

(14) The asphalt-concrete must be protected and transported to the street while hot and be at least 250 deg. F. when unloaded, just previous to spreading it. Each load must be dumped clear of the area upon which it is to be laid, and preferably on a sheet steel plate. The surface of the binder must be clean, firm, solid and dry when the asphalt-concrete is placed upon it with hot shovels and spread with hot rakes, to such a thickness that after it is fully compressed with a mechanical roller of at least ten (10) tons, the finished surface shall have a thickness at least one and one-half (1½) inches at all points; a slight excess being permitted to even up slight inequalities in the surface of the binder. The compression shall be attained by first smoothing the surface with a roller, and the rolling continued without interruption until thoroughly compacted and it conforms to the required grade and crown. Pavement next to curbs, headers, manhole, etc., frames must be rammed solid before rolling. All parts of the pavement inaccessible to the roller must be thoroughly compacted with heavy iron rammers. No asphalt concrete surface shall be laid when the weather conditions are unsuitable, nor unless the binder is clean, free from frost, hard and dry. Use of water on the roller on the surface of the pavement shall not be permitted; but the surface of the roller can be wiped with a little suitable oil or mixture of kerosene oil and water while rolling the pavement surface to prevent adhesion to the pavement.

(15) *Seal Coat.* Immediately after the completion of the rolling of the asphaltic concrete, a seal coat of asphalt-cement, liquified at a temperature of 300 to 350 deg. F. shall be spread upon its entire surface and evenly distributed with squeegees. Only a sufficient quantity to coat the surface and fill the surface voids without leaving an excess shall be used. This seal coat shall be immediately entirely covered with crushed rock screenings, or clean, coarse flintic sand, not ex-

ceeding one-quarter (¼) inch size and free from dust, which shall be evenly spread and thoroughly rolled with the above roller, and the quantity used shall be sufficient to leave a small surplus of screenings or sand to be worn away by traffic and weather.

(Note.—Somewhat better pavement generally results with crushed stone than with gravel in the pavement composition. Therefore, the engineer using these specifications, will strike out the words ("or gravel") in paragraphs 1, 8, 9, 10, 12, unless local conditions require or permit the use of suitable and approved gravel.)

REVISED SPECIFICATIONS FOR BRICK PAVING

Specifications of the National Paving Brick Manufacturers' Association for vitrified brick pavements on streets and highways are now undergoing revision preparatory to early publication. The revision comes as the result of recognized trends in modern engineering practice, and was determined upon by members of the National association in their annual meeting held Dec. 6 and 7, 1921, in Pittsburgh.

The revision will consist of expanding the present specifications and rearranging several sections so as to make the grouping more systematic. The revised specifications will include all that is included in the present volume with the addition of two new provisions, as follows:

1. Recognition and acceptance as standards of the 11 sizes and varieties of vitrified brick mutually agreed upon as standards by engineers and manufacturers in joint conference with Herbert Hoover, Secretary of the United States Department of Commerce, and officials representing other government departments, as described in the December, 1921, issue of Municipal and County Engineering.

2. Addition of a department calling attention to the particular adaptability of vitrified paving brick in the construction of sewer inverts, the smaller highway bridges and for other construction.

Ratification of the action of the Washington joint conference held Nov. 15, wherein 55 out of 66 sizes and varieties of vitrified brick were eliminated as unnecessary and contributing to waste, leaving 11 as standards, was unanimous on the part of the manufacturers. E. W. McCullough, manager of the Fabricated Production Department of the United States Chamber of Commerce, who is actively cooperating in Mr. Hoover's campaign to effect sane standardization and to eliminate waste in industry, addressed the brick manufacturers discussing the results of the Washington joint conference. Not only did the manufacturers ratify the action of the Washington joint conference, but they also adopted a resolution pledging their co-operation in assisting the permanent committee of ten, decided upon at Washington and to be composed of representatives of various national engineering societies, to bring about further eliminations as rapidly as conditions warrant and in proper manner.

Manufacturers reported that because of changes already apparent in specifications, showing that engineers the country over are adopting the standards set by the Department of Commerce, their production is rapidly being limited to the 11 sizes and varieties.

Actuated by recognition of the trend in brick pavement construction toward flexible wearing-surface the national association unanimously adopted a resolution announcing its preference for the general use of asphalt filler as follows:

Whereas, The National Paving Brick Manufacturers' Association through its contact with the requirements of the paving market, maintained through the members and field engineers of its Territorial Associations, is increasingly conscious of the trend in engineering design and construction toward asphalt filler, and

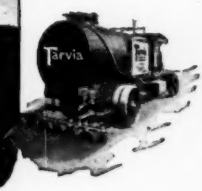
Whereas, Recent investigation discloses that approximately 60 per cent of all brick pavements laid in 1921 were so filled, and

Whereas, The Association interprets this increased proportion of asphalt-filled brick pavements as indication that the majority of engineers and public officials, using vitrified brick for paving, believe that the use of such filler, under specifications providing quality and method of using according or equal to those of the National Paving Brick Manufacturers' Association, is calculated generally to insure the construction of brick pavements equal in endurance and economy to the endurance and economy inherent to the individual brick as manufactured, and

Whereas, It is the traditional policy of this Association publicly to declare its judgment, from time to time, in respect to purposes which it regards as encouraging the wisest use of public funds for paving purposes.

Therefore, Be It Resolved, That the Na-

State Trunk Line No. 13 in Kilbourn, Wisconsin. Maintained with annual treatments of "Tarvia-B" since 1916



Good Roads that Grow Better—

MOST people are satisfied when the roads stay "as good as new." But not so the Road and Bridge Committee of Columbia County, Wisconsin.

They build good roads to start with and then, by far-sighted but inexpensive maintenance with "Tarvia-B," make those good roads better every year.

This extract from their letter will be of interest to all highway officials:

"Our experience in successfully maintaining our macadam roads with "Tarvia-B" is due not only to the excellence of your product, but also the rule we follow in Columbia County of surface treating macadam roads in good condition and giving them additional treatments of Tarvia annually.

"During the past couple of years, we have used clean limestone screenings ¾" size as a covering after applying the Tarvia. We believe we are adding just a little more Tarvia surface each year than the traffic wears off, as we have several macadam roads in this county that have been annually treated with "Tarvia-B" for the past six years and are in better condition at the present time than they were when first treated with Tarvia."

The use of Tarvia re-enforces the road surface and makes it waterproof, frostproof, mudless, dustless and automobile-proof. A road maintained with Tarvia pays for itself over and over again.

Tarvia is a coal tar preparation, made in a number of grades to meet construction, maintenance and repair problems.

Illustrated booklet describing the various Tarvia treatments free on request.

Tarvia
For Road Construction Repair and Maintenance

GOOD ROADS SHOW

Visit our booth at the Coliseum, Chicago, Ill., during the Good Roads Show of the A. R. B. A., *January 16-20, 1922.*

New York, Chicago, Philadelphia, Boston, Detroit, New Orleans, Birmingham, Kansas City, Salt Lake City, Seattle, Peoria, Atlanta, Johnstown, Lebanon, Youngstown, Toledo, Elizabeth, Buffalo, Baltimore, Omaha

The Barrett Company

St Louis, Cleveland, Cincinnati, Pittsburgh, Minneapolis, Dallas, Nashville, Syracuse, Duluth, Milwaukee, Bangor, Washington, Columbus, Richmond, Latrobe, Bethlehem, Jacksonville, Houston, Denver

THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver, St. John, N. B., Halifax, N. S.

tional Paving Brick Manufacturers' Association, assembled in annual conference in Pittsburgh, Pa., on Dec. 7, 1921, hereby expresses its confidence in asphalt-filled brick wearing surfaces for street and highway paving properly designed and built with acceptable materials and thorough methods. And that this Association hereby declares its preference for the asphalt-filled types of wearing surface.

Provided: Preferment of the foregoing type of brick wearing surface for general use shall be without prejudice to any other type which may possess peculiar adaptation to special local conditions.

Sewer Inverts and Small Highway Bridges

Extension of the Association's specifications to include information on the adaptability of vitrified brick for construction of sewer inverts and the smaller highway bridges was decided upon following a report by Will P. Blair, Vice-President of the Association. Attention was called to the fact that vitrified brick were proof against all acids common to the sewage flow, that their use would promote economy in sewer construction and that engineers frequently request information concerning this use of paving brick. As for the use of vitrified brick for the construction of the smaller highway bridges, Mr. Blair submitted evidence of highway and railroad bridges of paving brick located in various parts of the country which have been in service for more than 20 years and still are in excellent condition.

The annual meeting was presided over by O. W. Renkert, President of the Association and Vice-President and General Manager of the Metropolitan Paving Brick Company, of Canton, Ohio. In his address the President said that the outlook for the industry was increasingly bright and that by continuing to work hard and give honest value and service, members would find the year 1922 an exceedingly busy one. He pointed out the need for cutting production costs by scientific research into methods of manufacture.

Maurice B. Greenough, Executive Secretary of the Association, outlined a well-rounded program for association work in 1922, devoting attention on the one hand to extending educational facilities, and on the other to promoting increased economy in the manufacture of brick. It was his opinion that the year 1922 would see increased activity in the industry over the year 1921, probably as much as 40 per cent.

A. V. Bleininger, Homer-Laughlin Pottery Co., and chairman of the Technical Committee of the Joint Clay Products Research Committee, discussed the work of the committee and its relation to the paving brick industry. Thus far the research work had centered around kiln firing, the speaker said. He declared the investigators already were in a fair way to decrease coal consumption in burning brick.

CREOSOTED TIMBER FOR HIGHWAY BRIDGE CONSTRUCTION APPROVED

Realizing the economic importance of the use of well-treated timber for construction purposes, the U. S. Bureau of Public Roads recently instructed its engineers to use timber creosoted by the vacuum and pressure methods where justified on economic grounds. The instructions issued in January, 1921, practically prohibited the use of timber for highway construction purposes and were generally considered by state, county, city, and other engineers to mean that the federal government disapproved of the use of well-creosoted timber. The recent instructions state that the Bureau of Public Roads will not question the use of creosoted material where the following conditions are observed:

(a) Timber trestles or bridges constructed of creosoted material treated by the vacuum and pressure method.

(b) Timber floors constructed of creosoted planking treated by the vacuum and pressure method, laid laterally with a plain or tank treated wearing floor ("half-sole"); or laid laterally or longitudinally on edge, spiked together, and covered with a mastic wearing course.

(c) Timber floors, for light traffic where single floors are laid and not protected by any covering, constructed of tank-treated material or plain material depending on whether plain timber is more likely to rot out or wear out.

For permanence at low cost well-creosoted timber for construction purposes cannot be questioned. Its use for highway construction includes piling, bridge timbers, cribbing, posts, culverts, and other miscellaneous uses, and the saving made possible by utilizing this class of material makes additional funds available for building and maintenance purposes.

WATER WORKS SECTION

SAVING $52 PER DAY ON SMALL WATER MAIN RECLAMATION JOB

By the use of equipment on a job so small that ordinarily the contractor would employ only hand labor, Q. J. Winsor, of Elyria, Ohio, saved $52 a day on a small water main reclamation job, says the Bulletin of the Associated General Contractors.

Mr. Winsor describes the job and his method of handling it in the following words:

A saving of $52 a day was made on a small water-main reclamation job, because the superintendent found available a small crane and put it to work, instead of digging the pipe out by hand.

About 300 ft. of cast iron pipe, that had been in the ground 15 years, had been cut out of the present water supply system and the city thought it was worth salvaging. This pipe lay under an old water-bound macadam road at a depth of about 6 ft. in soil that had become about the hardest kind of hard clay.

As the city had no excavating equipment of its own and the job was very small, the usual thing would have been to dig it out with pick and shovel. In this case the superintendent happened to hear of a light crane that could be hauled quickly to the job behind a motor truck, and decided to try it out.

The crane had wide steel traction wheels and was towed the two miles to the job behind a 3-ton truck, the trip taking about 45 minutes.

The equipment was a half-yard excavating bucket, reaved to get the greatest closing power and equipped with teeth. The bucket had to dig through about 8 ins. of macadam before it struck the hard clay. No trouble was experienced in doing this and fair loads of clay were taken out each trip. The trench was made just the width of the bucket, and after it got down about 6 ft. digging became a little slower, as the buckt did not dig sufficient side clearance to allow it to drop readily.

Care had to be taken as the bucket approached the pipe so as not to break it, but this did not slow up the work much. No pipes were broken and the bucket cleaned out clear to them, so that all the shovel work necessary was to dig out the joints.

The trench was dug 3 ft. wide and from 6 to 7 ft. deep. The total time taken was a day and a half, though two days were counted to allow for getting the crane to and from the job.

The superintendent said of this job that, at the rtae his men were working on other and previous jobs, the crane took the place of about 16 men. He was paying a regular rate of 50 cts. an hour; so figured on a 9-hour day basis, without the crane the job would have cost $144. With the crane costing $20 a day including operator and fuel, the cost was $40, which deducted from $144 leaves a net saving of $104, or $52 a day.

It is very probable that similar savings may be made on many small jobs.

HOW THE ELECTRIC RATE IN SPRINGFIELD, ILL., WAS REDUCED FROM 13c to 6c

By Willis J. Spaulding, Commissioner of Public Property, Springfield, Ill.

In 1894, as a protest against the high electric rates then prevailing for both street lighting and commercial use, 60 citizens pledged their credit for $1,000 each, to build an electric plant. A corporation was organized, known as the Capitol Electric Company, which at once entered into a contract with the city to erect and operate an electric utility within the city, to be conveyed to the city whenever the net earnings had met investment cost with interest. The plant paid for itself during the first five years of operation, and was deeded to the city without encumbrance. The total investment to date of transfer was $84,569.44, and the property transferred embraced what was then a modern plant and a distribution system. During these five years the Capitol Company had done a commercial business in addition to lighting the public streets.

At that period cities in Illinois had not yet been granted power to carry on commercial electric utilities, and largely for

this reason the transfer of title to the city was immediately followed by a transfer back to the Capitol Company of such of the power station equipment as was actually devoted to commercial business, and the execution of a lease contract whereby the city leased the street lighting portion of the utility to the Capitol Company for the ensuing 5-year period, expiring June 18, 1905. During the 5-year period the lease was sold to the present owners.

At the expiration of the lease in 1905, the city was met by a refusal to surrender the leased property. Injunction proceedings were begun by both sides in an endeavor to secure or retain possession, each claiming the other to be in its debt to a considerable amount under the terms of the lease. The matter was finally disposed of in 1906 by the city taking forcible possession of the property through its Police Department. Since this time the city has been in full possession.

No commercial business was taken on by the city until the fall of 1915, 2 years after the passage of the Municipal Ownership Act granting to cities the right to operate commercial utilities, a right theretofore withheld except as to water.

In 1909 I was placed in charge of the Water Works, which was already municipally-owned; and in 1911 the Electric Plant was placed in my department also. The pumping station is located on the Sangamon River, 4½ miles from the center of the city, and 4 miles from the Electric Power Station, at which location there was no condensing water available. It was self-evident that these two utilities could be operated together under one roof much more economically than as separate plants. It was also self-evident that if the city was to operate an electric power plant for street lighting, it could, with comparatively small additional expense, provide light and power for general commercial use. Of course, this is true in the case of most any city which is doing its own street lighting. There is, perhaps, no business in which the cost of production falls so rapidly with the increase in output; for instance, our cost of production per kilowatt hour since we have entered the commercial field is about one-third what it was when doing street lighting only. The city which operates an electric plant for street lighting only, is inconsistent from the standpoint of economy; for if the city can afford to produce a comparatively small output for street lighting, it can much better afford to take on commercial business, which in these days means large blocks of day power, which will tend to level up the load for a full 24-hour day and give the city the great advantage of using its investment and its employees' full time instead of only part time.

In 1913, an ordinance for the purchase of new electric equipment for the purpose of combining the Water and Light Plants was introduced in the City Council. It was the avowed purpose of the city to enter the commercial field, which at once started a vigorous fight on us by the private utility corporation which occupied the field. The City Council divided on the ordinance and defeated it 3 to 2.

Under that provision of the Commission Form Act permitting the initiative and referendum, the ordinance was then initiated by petition and passed by popular vote at a special election held in January, 1914. In the campaign preceding this election the subject of municipal operation of a commercial electric utility was thoroughly debated by opposing members of the City Council and by the public. The newspapers divided on the question and gave the matter wide publicity. Nearly all public schools of the city contain auditoriums with seating capacity for several hundred people, and meetings were held in these auditoriums and other public places attended by large crowds, and very keen and general interest was aroused.

After the adoption of the ordinance, a contract was entered into for the new equipment; but the private company brought pressure to bear on the manufacturers and persuaded them to attempt to evade delivery, which resulted in about a year's delay.

The city has installed three additional generating units since, every purchase being attached in the courts by one or more petitions for injunction. Some 20 suits were filed in all. These suits were, for the most part, directed against the Municipal Ownership Act of 1913. This Act has been upheld by several decisions of the Supreme Court of the state, and may now be considered as settled law.

One of the most important issues raised was recently decided by the United States Supreme Court. In this suit it was sought to compel all municipally-owned utilities to be placed under the jurisdiction of the State Utilities Commission. This would mean that no city could establish a municipal utility without first securing from the State Utilities Commission a certificate of convenience and necessity; which would, no doubt, be denied upon the theory that a public utility should be operated as a

monopoly, and if the field is already occupied by a private concern, such concern should be protected. The attorneys for the company argued that to compel a private utility to submit to control of a state commission, and to exclude cities from such control, was a discrimination against consumers, and therefore in violation of the Constitution of the State and of the Constitution of the United States. We contended that municipally-owned utilities were subject to regulation by the City Council, and that the State Legislature had a right and might properly provide for the regulation of the rates and rules of city-owned utilities by a different method from that used in the regulation of privately-owned utilities; and that such difference does not constitute discrimination. The company argued that under municipal ownership the poor consumer had no protection. The remark made by Justice Holmes of the Supreme Court is significant as showing the real purpose of the suit. The Judge says: "What the plaintiff (company) complains of is not extortion, but on the contrary, charging such rates as draw the plaintiff's customers away." This has been a moot question ever since regulation by state commissions began, and the decision will be of vital interest to cities owning utilities, anywhere in the United States. It protects the principle of Home Rule, which is so essential to the upbuilding and the progress of Municipal Government.

In 1916, the company raised another interesting question. It charged that the city was selling electric current at less than cost, in violation of the statute which provides that municipally-owned utilities must charge such rates as will make them self-supporting. Armed with a court order, the company employed auditors from outside the state and took possession of all our books of account. After a searching investigation, these auditors slipped out of town without making public their finding. As a matter of fact, the City Plant was earning a generous profit notwithstanding the rates were nearly 50 per cent less than company rates.

The Municipal Electric Plant began in a very small way, but has grown rapidly. Four generating units were contracted for during a period of about 6 years, every one of which involved a legal battle and a special election. The sentiment in favor of public ownership has steadily increased. This was especially shown in a recent bond election.

Because of the great difference in rates, many citizens were skeptical in the beginning, and thought it could not be possible that the City Plant was self-supporting while selling current at such low rates; but as time went on and the report of the Certified Public Accountants who audited our books at the end of each fiscal year showed a constantly increasing surplus, our citizens became convinced.

Feb. 28, 1921, the end of our last fiscal year, the value of the Springfield plant was $325,947.55. Only $38,000 of this sum was received from taxes, the balance being paid from earnings or from money advanced by customers. Additions and extensions amounting to over $200,000 have been made during the past 8 months. While the city had won the important legal battles, nevertheless, the company was able to tie our hands financially, on account of the cloud put upon our bond issues while suits were pending. To meet this situation, the city required its customers to pay in advance the cost of extensions, repaying the money in service. More than $100,000 has been advanced for new construction in this way. This method of financing has been a life-saver to our enterprise, and we heartily commend it to others who are hampered financially.

On March 10th last, the company's franchise expired. At that time the City Plant had about one-third of the commercial electric business. It was agreed that the company's property should be appraised, the value fixed by a Board of Arbitration, and the city to take it over. The property included a central station heating system as well as an electric system. Pursuant to this plan, Delos F. Wilcox, of New York, was chosen as arbitrator to represent the city; Wm. J. Hagenagh, of Chicago, to represent the company; and John F. Wallace, of New York, was selected by a committee of the Chamber of Commerce as a neutral to cast the deciding vote. A very complete appraisal and exhaustive study of the property was made, E. W. Bemis, with his engineering staff, doing this work for the city. About July 1st, 2 reports were filed by the arbitrators. The majority report signed by Wallace and Hagenagh fixing the value at $2,108,212, and a minority report by Mr. Wilcox, fixing the value at only $1,000,000, or less than half the value found by the majority. The following paragraph is taken from Dr. Wilcox's report:

"I am fully advised that in case the people of Springfield, at the coming bond election, reject the award of the Board of Arbitration as fixed by the majority of

its members, the company intends to close down its plant forthwith, hoping thereby to provoke a storm of public discontent and anger which it will strive to direct against Commissioner Spaulding and his associates in the City Government in the expectation that under the whip and spur of calamity, the city may be forced to confer upon it a non-competitive franchise which will put the Municipal Lighting Plant out of commission and give to the company a 30-year lease of life for the continued occupation of the public streets of Springfield and for the exploitation of a profitable monopoly in the electrical field, with central heating service continued as an incident thereto. Notwithstanding this "fearsome" prospect as an alternative to the payment of a price, which, in my opinion, is more than twice as much as the property would be fairly worth to the city, I cannot see my way clear to sign the award of the majority or to recommend its acceptance by the electors of Springfield."

In keeping with the above forecast made by Dr. Wilcox, the company publicly announced that all light, power and heat service would be discontinued on August 15th, unless it was granted a long-time franchise which would prohibit the Municipal Plant from taking on any additional business, thus giving the company a monopoly. This would mean that all the principal industries in Springfield, including a number of coal mines, would be shut down, leaving thousands of men and women unemployed. Practically the entire business district and 400 homes in addition are supplied with central station heat, and it would have been very difficult, if not impossible, for all of these to protect themselves against approaching cold weather. However, this harsh threat only served to incense the people and stimulate opposition to the company. It was evident that the proposed exclusive franchise would be defeated by an overwhelming vote. Just 2 days before the election the company suddenly announced that it would accept a 20-year franchise extension, which would not in any way hamper the Municipal Plant.

It was under these circumstances that the question of voting bonds to purchase the company's plant upon the terms of the award of the majority was submitted. To accept the award would mean that the city was investing at least $1,000,000 more for an old- run-down and out-of-date property than a new property or the same capacity could be installed for. It would mean the water-logging of the Municipal Plant, thus burdening public ownership in Springfield with the same evil of overcapitalization for which we criticise the private corporations. As head of the Light and Power Department, I advised against the acceptance of the award, and as an alternative, urged the voting of $400,000 in bonds for the enlargement of the City Plant. The award was voted down by about 5 to 1, and the bonds for enlarging the City Plant carried by 4 to 1. The escape of the city from great loss in this arbitration was due to the thorough and conscientious appraisal work done by E. W. Bemis, who has the protection of the public ever in mind, and by the great industry and clearheadedness of Dr. Wilcox, who proved a bulwark of defense for the city.

We have since sold our bonds and are now rapidly enlarging and extending our plant. When this $400,000 is expended, we will have as large an electric plant as we would have received from the company, and our debt will be only $400,000 instead of $2,108,000. Of curse, we shall not have the old heating system; but this would have been a liability rather than an asset.

After exhausting every other recourse to block the city, the company has at last reduced its electric rate to practically the same as the city is charging endeavoring to stem the tide of business which is going to the City Plant.

The private plant in Springfield is one of the Hodenpyle-Hardy Group of 60 or more utilities scattered over the country. Their rates in Springfield are about ½ the rates being charged in other cities where the cost of production is approximately the same. Just how the company will explain this inconsistency, we do not know. The company's new rates were announced about the middle of October and became effective on bills which were due October 31.

We have been a little uneasy as to what the effect on public sentiment would be; but so far we cannot find that there has been any change in the disposition of the citizens to stand by their own plant for which they voted bonds. We are now attaching business at the rate of 400 to 500 consumers per month, which is almost as many as the City Plant acquired in a whole year heretofore.

The present sentiment in Springfield in favor of Public Ownership is based on the demonstration which has been going on during the past 6 years. We have felt it to be one of the duties and responsibilities of the department to keep the citi-

zens informed. We have made it a rule never to over-promise, and have secured public confidence by making good what we *do* promise. Following in the footsteps of Mr. Koiner, of Pasadena, Calif., we have kept before the citizens the economic advantages of the City Plant, which accrue not only to those receiving service from the city, but to those on the company's lines as well, because of reductions in rates which the company was compelled to make. The private company has made three reductions in rates since the city entered the commercial field. Its lighting rate was formerly 13 cts. per kilowatt hour, less 10 per cent for prompt payment. Its rate now is 6 cts., the same as as city's rate. The total savings to electric users of Springfield amount to not less than $200,000 per year.

Last year our gross income was $161,-311.29; the surplus above operating expenses and fixed charges was $50,153.49. The gross income this year will be about $220,000 and the surplus $80,000. The average cost per K.W.H. delivered to customer's meter last year was 1.996 cts., or practically 2 cts. per K.W.H. This year the average cost is running about 1¾ cts. The cost includes depreciation, bond interest and principal.

The city's rates are as follows:

For Lighting—6 cts. for the first 30 K. W. H.; 3 cts. for the next 70 K. W. H.; 2¾ cts. for all over 100 K. W. H.; minimum—50 cts. per month.

For Power—1¼ cts. per K. W. H., plus a service charge.

Cooking Rate—1 8-10 cts. per K. W. H.

When the new equipment, which is already delivered, is placed in operation, the City Plant will have sufficient capacity to supply the entire needs of Springfield.

The great inventions by which the forces of Nature are harnessed and put to the service of man, are beneficial only to the degree that they are placed within reach of the common people.

The purpose of the Municipal Light and Power Plant is to bring the magic power of electricity—the greatest invention of the 20th century—within the reach of all. It is a co-operative enterprise established by the citizens of Springfield for the benefit of all. It is neither Democrat nor Republican. It has no relation to politics whatever. The 10,000 horsepower capacity of this plant is a giant slave in the service of the people waiting to do their bidding, at the cost of upkeep only.

Electricity does many big things and it also does many little things. It is an indispensable servant in the house. It will cook your food, warm your room in cold weather and operate cooling fans in hot weather; provide comfortable warming pads to be applied to the body in case of illness; sweep the floor, wash and iron the clothes, run the sewing machine, and do many other things too numerous to mention. It will furnish light and power for all purposes.

That the Municipal Electric Plant is appreciated is proven by the fact that the number of homes in Springfield receiving electric service has nearly doubled since the city began selling current.

The coal oil lamp is being put aside. Electric cooking is being substituted for gas. The city's special cooking rate makes electric cooking cheaper than gas.

Our lighting rates are nearly 50 per cent lower in Springfield than in other cities of similar size. Our power rates are so low that they beckon to manufacturers of every kind to come to Springfield and reduce their factory cost. Springfield bids fair to become the most completely electrified city in the world.

(Editor's Note:—The foregoing paper by Mr. Spaulding was presented before the convention of the Public Ownership League of America, held in Chicago on Nov. 19-21. Like any other article published in Municipal and County Engineering, this article is open for discussion by our readers. Discussion is always encouraged in the interest of equity and advancement of knowledge.)

MISCELLANEOUS PROBLEMS IN SEWER DESIGN AND MAINTENANCE

By Milton J. Ruark, Division Engineer of Sewers, Department of Public Improvements, 311 Courtland St., Baltimore, Md.

The design and the maintenance of a sewerage or drainage system are two distinct and independent functions. Usually the engineer responsible for the designing is especially trained in this particular branch of engineering; is qualified to make the necessary surveys and calculations, and can execute detailed plans and specifications to the satisfaction of the State Board of Health or other authorities. Unfortunately, however, the consulting or designing engineer seldom has the opportunity to operate and maintain the systems, which he has planned. His knowledge of maintenance problems is,

therefore, mostly obtained from others, and is not his own experience. It is, therefore, to be expected that he will not be able to anticipate all of the maintenance difficulties, some of which may be due to local conditions, and the burden of successfully operating the system must be solved by someone else who may or may not be particularly qualified or have knowledge of the principles involved in the original design. If the engineer has exercised ordinary skill, and given sufficient thought and study to the subject so that the proper and most suitable system is adopted; if designs are prepared and detailed in an accurate manner; and, furthermore, if the plans and the specifications have been followed out by the engineer in charge of the construction, it is safe to say that maintenance problems should be few, and of such a character that only minor modifications to the system will be required, and the operation cost will therefore be small.

On the other hand, maintenance problems are often numerous, difficult to correct, and involve unreasonable up-keep charges because the sewerage system has been either poorly designed, or as is more commonly the case, constructed in a haphazard manner without sufficient engineering supervision. Where the designing engineer of the system is one who is familiar with the maintenance problems, he will, of course, avoid many errors and pitfalls that he has become aware of through experience.

The Sewerage and Drainage System of Baltimore, approximately 90 per cent of which was built between the years 1906 and 1916, has now been in service about 10 years. At the time when preliminary plans were submitted and approved, there was much difference of opinion as to the best methods of design to follow. In a great majority of instances it is clear and beyond dispute that the designs of the engineers, adopted and carried out in detail, were the best ones although there are a few cases where equal or better results might have been obtained by using some other and perhaps less expensive method.

Unobstructed and Clean Sewers

One of the chief results to be obtained by the sanitary engineer is a sewerage system that will be free of obstructions, chokages and foul odors, and which can be kept in this condition by ordinary maintenance labor. The prevailing impression is that if the grades of the sewers are sufficiently steep no trouble will be experienced with deposits forming in the sewer. The problem, however, does not end with the designer. He may have provided for sufficiently high velocities, and nevertheless when the sewer is put in service obstructions will frequently occur especially if good construction work is not insisted upon.

More important than good grades is a selection of good quality pipes, and skillful pipe laying. Pipe must be smooth, straight, and in continuous alignment throughout without the irregularities and kinks which so often occur due to the interference of other underground structures. Each joint must be made as tight as practicable, and the well established principle of straight horizontal and vertical alignment between properly spaced manholes must be observed. One of the chief causes contributory to obstructed sewers is tree roots. Where skillful pipe layers are employed, and good tight joints are made, the probability of an obstructed sewer from this cause is reduced to a minimum. Roots from the common poplar tree are responsible for most of the trouble in Baltimore, and occur more frequently in the house connection than in the lateral sewer. This trouble, however, has not been experienced in storm water drains, and is probably accounted for by the fact that small drains carry little or no flow during dry weather. Even where bituminous compound joints have been used as a precaution against tree roots, they have found their way into the sanitary sewers. It is a recognized fact that poplar trees have little value as shade trees, and that the roots also cause failures of cement or brick sidewalks. For this reason an ordinance has been passed in this city prohibiting the further planting of this species of tree. The demand and market for many of the complicated mechanical sewer cleaning apparatus so widely advertised by manufacturers is due to the fact that many municipal sewerage systems in this country have been poorly designed and constructed.

Plumbing—An Essential Part of the Sewerage System

When the sanitary sewerage system of Baltimore was put in service, each building, premise, and establishment was required to be connected to the sewerage system at the expiration of 60 days after being notified by the Health Commissioner. The regulations required that the existing plumbing be made to conform

with a revised plumbing code under which all wastes of a polluted character were required to be disposed of into the sanitary system, and rainwater or other non-polluted waste into the storm water system. Rain leaders, which were permitted to be discharged upon the surface, were connected to the storm water system at the option of the property owners. These regulations were enforced in all instances even where a building was connected to a private sewer, and considerable money had to be spent in rearranging existing plumbing to conform to the new regulations. In cases where property owners failed to comply with this notice within a reasonable time, the health authorities had the power to make these connections to the city system, and the cost of the work became a lien upon the property. Where the property owner was not able financially to do this work, the city also arranged to have the work done by the owner's plumber, the owner paying the cost, with interest, in five annual installments. The rigid enforcement of the above regulation; the elimination of all cesspools and old outside running traps, which are still in use in many cities, has done much to improve sanitation in Baltimore. Notwithstanding that the reconstruction of the house plumbing and the cost of making sewer connection has involved an expenditure, according to the least conservative estimate, of $8,000,000 on the part of the property owners, it has been demonstrated that the benefit derived has justified the course taken by municipal officials. In the business districts the majority of down-spouts are connected direct to the storm water drainage system. The practice of making separate connections to the storm water system has increased, and it is a question whether it is not better to provide a separate connection in order to dispose of all water from roofs, area-ways, subsoil drainage, and water from garage floors. If this practice were followed, large quantities of rain water would be eliminated from the surface of streets; but some authorities claim that it is better to discharge water on the surface, as it tends to keep the streets in a cleaner and more sanitary condition.

Catch Basins

With the exception of a few low-lying drainage areas there are no catch basins in Baltimore, and it is not likely any will be built in the future. Most of the storm water drains are self cleaning; and the building of catch basins would therefore serve no useful purpose, but would probably become a nuisance. Catch basins are very expensive to clean out. They soon fill up with silt, and it is difficult if not impossible to prevent street sweepers from disposing of street sweepings in these inlets in order to lessen their labor. Furthermore, catch basins often retain a good deal of decomposed matter, and they cause complaints because of odors, and prevent a free circulation of air through the drainage system.

Manhole Covers

Although the design of manhole covers would seemingly play an unimportant role in sewer design, there is room for much improvement along this line. Where the separate system is used, covers for sanitary sewer and storm water drain manholes should be clearly marked with such words as "Sanitary Sewer" and "Storm Drain" so that all municipal employees can tell the kind of sewer without taking the cover off. A penalty should be imposed for removing these covers, and the amount of the fine should be marked on the sewer. Where the separate system of sewers is used, the manhole frames and covers should not be of the same size for both systems. Unless the covers are of slightly different diameters they will be interchanged and cause much confusion in maintenance work. For example, snow is likely to be dumped into sanitary manholes under the impression that it is being disposed of into the storm water drains, which practice causes much trouble.

During the early days of the Baltimore Sewerage Commission six holes, each 1 in. in diameter were provided for in the top of manhole covers for ventilation and for removing them. As the sewers get ample ventilation through the house stacks this number was reduced to two without any ill effects. Were it not for the fact that some means have to be provided to take the covers off, no holes would be put in them at all. A good deal of ground water would thus be eliminated from the sewerage system which is treated at the sewage works.

Complaints have been made because of loose manhole covers which rattle when traffic passes over them. Experience at Baltimore has shown that the best way to remedy this condition is to have all manhole frames and covers inspected at the foundry. Only those castings that fit well are selected. They are bought by the

city, and furnished to the contractors who are building sewers.

Lampholes and Stand Pipes

Although lampholes were built on the sanitary sewers of Baltimore when the system was first installed, this practice has since been discontinued. They are a source of trouble as mischievous children remove the lamphole covers with little difficulty, and drop sticks and rubbish in the sewers, which become choked. If sewers become obstructed, lampholes are of little or no value in clearing them, and it is seldom that they facilitate maintenance work in any manner whatsoever. Furthermore, even when carefully constructed the lamphole will frequently settle and break away from the lateral sewer due to unequal settlement. House connections, which are made from deep sewers by means of standpipes, are also a source of many troubles due mostly to settlement.

Garage Connections

It is unlawful in Baltimore to connect garage floor drainage to the sanitary sewers. Thus, one of the main causes for gas explosions in sanitary sewers is prevented, although explosions have caused serious accidents in many cities. There is no record of explosions in any of the Baltimore sewers. It is permissible to connect garage drainage to the storm water drains, but the plumbing regulations require that an approved trap of ample capacity be installed on the house side of the sewer connections so as to intercept any gasoline or oils that might otherwise flow into the storm water drain.

Flush Tanks and Flushing Connections

One and one-quarter inch taps from the water mains of the city were originally extended to each terminal or dead-end manhole in order to flush out the sanitary sewers as the occasion required. The practice of installing these taps has also been discontinued as it has been demonstrated that only occasional flushing is necessary, and that the connections often rust out and become leaky in a short period of time. For similar reasons the use of flush tanks has been limited to serve sewers which are laid on very flat grades, and their use even under these circumstances is questionable. Moreover, there have not been many complaints of deposits in sanitary sewers that are at or near the end of the lines.

In Baltimore four men spend all their time in making periodic inspections of all manholes. They remove from the manhole benches such things as sticks, rags, bottles and other material that might choke the sewer. Often they find that some sewers are partially obstructed, and they immediately have these obstructions removed. This work reduces the amount of money expended in clearing the sewers, and at the same time there are fewer complaints from property owners because of flooded cellars.

Sewage Pumping Stations

A gravity system of sewers should be installed whenever it is possible so as to reduce pumping to a minimum. The design of a pumping station, either large or small, requires very careful consideration and a vast amount of detail work. Extreme caution must be exercised that the proper type of mechanical and electrical equipment is selected. Ample space for units to meet future requirements must be provided, and reserve units must be installed in case of a breakdown. The average daily flow at the main pumping station in Baltimore is 25,000,000 gals. and the maximum flow has at times reached 38,000,000 gals. per day. Nevertheless, this station has been in continuous service without interruption, and the successful operation of a station of this size is assured if the equipment is first class, kept in good repair, and a competent, reliable staff of power plant operators is provided. That pumping stations of both large and small capacities can be located in congested districts without becoming objectionable to adjacent property owners, and further that sewage screenings can be disposed of by incineration within the pumping station without causing a nuisance has been clearly demonstrated by the operation of such a station in Baltimore.

Sewage Treatment

One feature of sewage treatment that has demonstrated itself is that it is practically impossible to eliminate complaints because of odors from a large plant. A sewage treatment plant of any size is bound to give off odors and the engineer who claims that he can eliminate them altogether will be disappointed when he faces actual operation conditions. Theoretically a certain method of sewage treatment may be used without producing odors, but when all weather conditions are encountered, when wide variations in sewage flow occur, and when the plant is operated by poorly trained men who are

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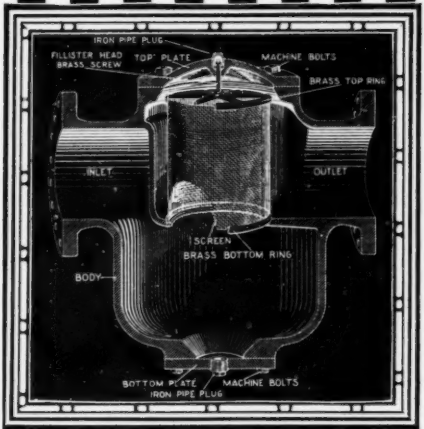
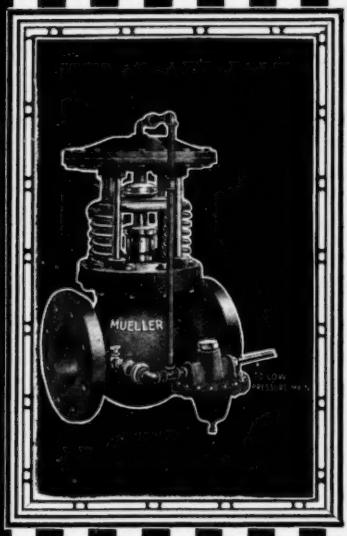
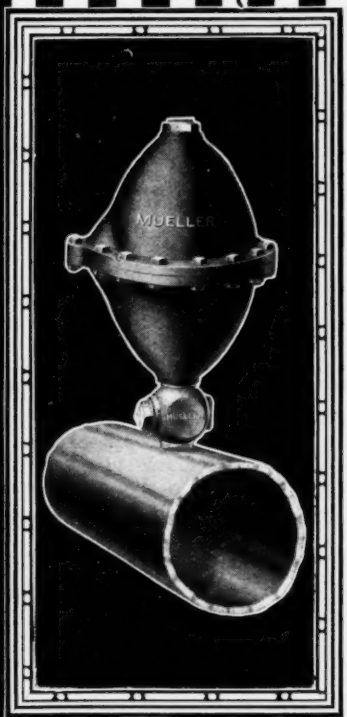






negligent, aerial nuisances almost invariably arise. Very often complaints from odors are unfounded or are exaggerated. Human psychology is such that people, who live in the vicinity of a sewage treatment plant, often imagine that they get odors from the plant when such is not the case. Where the land can be bought at a low price, it is advisable to buy a large tract as was done at Baltimore in order to isolate the plant, and reduce the number of lawsuits which are bound to follow. After the plant is built, any land bought in the vicinity of the plant can be resold with the provision that the purchasers will not enter suit against the municipality.

Conclusions

Within the past 10 or 15 years great advances have been made in sewer design. The rational method of designing storm water drains has been introduced. The separate system is becoming more firmly established. A great deal of information has been compiled as to the hydraulics of sewers, and many other valuable data have been obtained. But much remains to be done. Engineers should ascertain with a greater degree of accuracy the value and advisability of using concrete for sewers as compared to terra cotta vitrified earthenware pipe, the effect of various kinds of sewage and industrial waste flowing under different velocities and conditions both in concrete and brick lined sewers, and the life of these materials under such conditions. Engineers should as a matter of public service make a more detailed study of the storm water run-off from various kinds of pavements, etc., the percentages of water entering different types of inlets under varying surface grades and conditions. It is true that engineers have not learned the last word pertaining to the design and construction of sewers, but much ground has been covered. The most fertile field for investigation and research in sanitary science lies in the field of sewage treatment, and it is not unlikely that within a few decades our present methods of sewage treatment will give place to other methods, which are more economical and efficient.

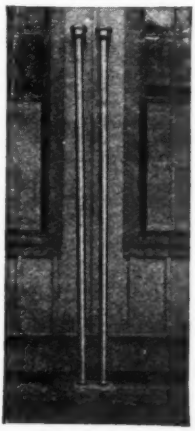
The foregoing paper by Mr. Ruark was presented at the 1921 convention of the American Society for Municipal Improvements.

CAST IRON WATER SERVICE PIPE

Although the larger sizes of cast iron pipe have long been used for services, 2-in. pipe has not been advertised for this purpose until very recently and many letters of inquiry have developed the fact that water works men were unaware of its manufacture. We believe, therefore, that this product is of sufficient interest to warrant description and discussion.

For some years there has been a gradually increasing amount of thought given to the need for a better and more durable service pipe. This need was emphasized in the "Report of the Committee on Service Pipe" of the New England Water Works Association, some years ago.

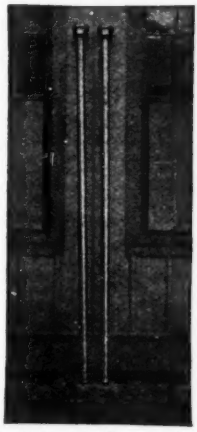
After a careful investigation, covering several years, they list the 6 important requirements for a good service pipe. In the order of their importance these are, (1) that it should not affect the water



TWO-IN. CAST IRON WATER SERVICE PIPE CAST BELL DOWN IN 9 FT. LENGTHS.

passing through it in such a manner as to make it injurious to the health of those using the water; (2) that it should not have a deleterious effect on the appearance, taste, or odor of the water even though not injurious to the health; (3) that it should have a sufficient capacity to give adequate service at all times; (4) that it should be strong and durable; (5) that it should be easily laid; (6) that it should be inexpensive.

About 10 per cent of the larger cities of the country are listed as using cast iron for at least part of their services and these cities find that it is exceptionally satisfactory. One engineer has stated that nothing will ever reduce the loss of water through leakage so much as the general adoption for service of cast iron pipe with joints that will stay permanently tight.



2-inch Service Pipe cast bell down in 9-foot lengths

Cast Iron Service Pipe

Bell and Spigot Joints

One engineer has stated that nothing will ever reduce the loss of water through leakage in distributing systems so much as the general adoption for services of cast iron pipe with joints that will stay permanently tight. Exactly this type of pipe is offered in U. S. Cast Iron Bell and Spigot Service Pipe.

In most cities the service pipe is laid by regular water works employees who are perfectly familiar with lead-poured bell and spigot joints. So that this type of installation results in a very tight line which, at the same time, has all the flexibility of a regular bell and spigot main.

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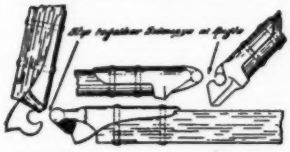

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It has been fully demonstrated that water conveyed in cast iron pipe is unchanged in quality. The minimum diameter recommended for cast iron service pipe is 2 ins. This size is amply large for ordinary needs, particularly as cast iron pipe does not fill up rapidly.

In most cities the service pipe is laid by the regular water works employees who are perfectly familiar with lead poured bell and spigot joints. This results in a very tight line which at the same time has all the flexibility of a regular bell and spigot main. Several water works superintendents have remarked the absence of leaks in this type of service.

In connection with the report mentioned above the following table was given to show the comparative life of some of the materials which have been used.

	Years Before Trouble Begins	Life of Pipe (Years)
Plain iron or steel	12	16
Galvanized	15	20
Lead	10	35
Lead lined	10	23
Cement lined	14	28

The useful life of cast iron pipe is variously estimated at from 100 to 200 years. Cast iron is by no means the most expensive service pipe and when durability is considered it is often the cheapest.

The cast iron service pipe of the United States Cast Iron Pipe and Foundry Co., here illustrated, is cast vertically with bells down so as to insure a perfect metal. The standard length for the 2-in. size is 9 ft. For service 3 ins. and over the standard bell and spigot water pipe is furnished in 12-ft. lengths.

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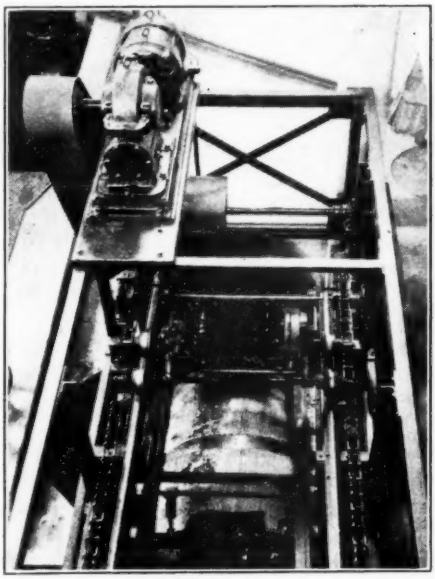
The screen surface proper is a cylinder made either of perforated plates or the Link-Belt Straight-Wire Screen. The Straight-Wire Screen consists of bronze wires stretched tightly across a bronze frame. The clear opening between the wires is 1-32 in. or less.

The sewage enters from the outside of the cylinder, and is discharged at one end from the inside; 90 to 95 per cent of the total screening area is submersible, in other words effective. Seal rings separate the clarified from the raw sewage.

The sewage is cleaned by revolving brushes which always travel in line with the openings, never across them. This feature and the small openings made possible by the Link-Belt Straight-Wire



LINK-BELT SEWAGE SCREEN, 3 FT. DIAMETER AND 3 FT. LONG, IN SEWAGE TREATMENT PLANT AT PLEASANTVILLE, N. J., LOOKING DOWN ON LEFT HAND SCREEN FROM UPPER PLATFORM.

Screen insure the removal of all but the finest solids in suspension.

No parts of the driving machinery are hidden; all parts of the screen can be inspected and cleaned without interrupting the operation..

Two of these machines are now in operation at the Sewage Treatment Plant of the City of Pleasantville, New Jersey, and are giving excellent account of themselves. From 70,000 G. P. D. one screen removes 4 cu. ft. of sludge, a rate of 57 cu. ft. per 1,000,000 gals.

The illustration shows the left hand machine covered with the Link-Belt Straight-Wire Screen.

Engineers who have inspected the plant speak very highly of it, and even those who doubted the utility of screens for such work, are now incorporating this machine in their designs.

Construction News and Equipment

METHODS AND EQUIPMENT EMPLOYED IN BUILDING CONCRETE ROADWAY ON MUSKEGON-GRAND RAPIDS, MICH., TURNPIKE

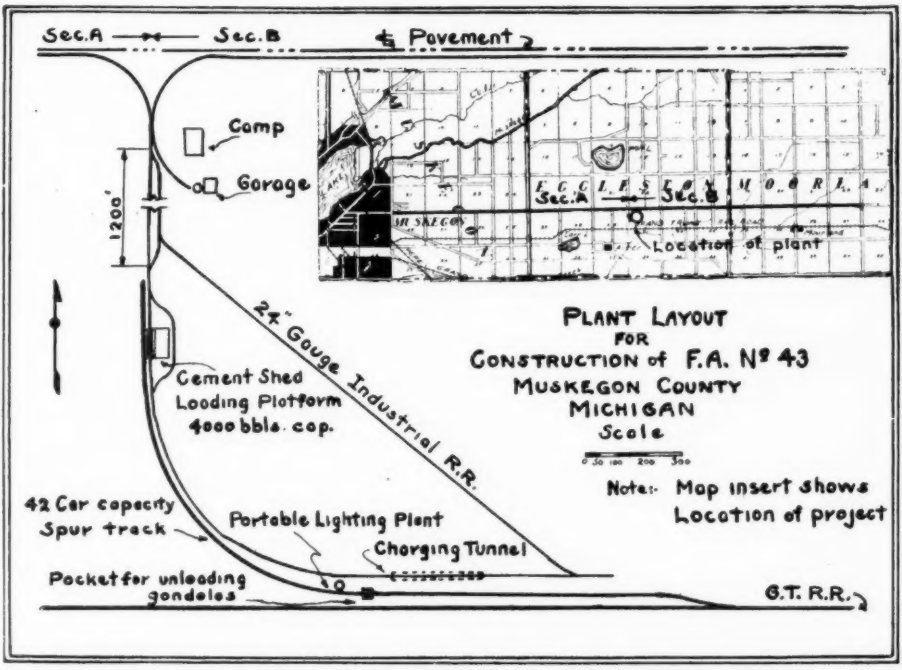
By C. E. Foster, District Engineer, Michigan State Highway Department, Grand Rapids, Mich.

Measured in miles of completed pavement, the road construction season of 1921 was a record breaker for the Michigan State Highway Department. Approximately 315 miles of hard surface road were built in sections of varying length and with nearly every type of concrete paving equipment in use, remarkable progress was made on several of the larger contracts.

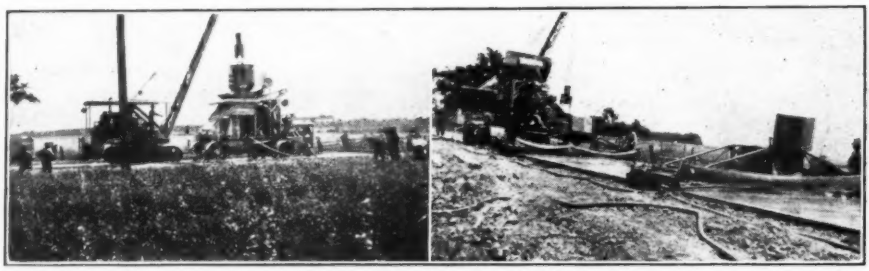
One of the most interesting jobs completed in 1921 was Federal Aid Road No. 43, Sections A and B, 14 miles in length, located directly east of Muskegon on the Muskegon-Casnovia-Grand Rapids Turnpike. The contract was awarded in April, 1920, to G. P. Scharl, of Muskegon, Michigan, but due to an acute car shortage it was impossible to move sufficient gravel and sand from the Grand Rapids and Kalamazoo pits to complete the project in 1920 and only five miles of pavement were laid during the season, the remainder being completed in 1921.

The alignment of the road is practically a tangent for the entire 14 miles with a maximum grade of 2 per cent. The pavement is 18 ft. wide, 7 ins. thick at the edges and 8 ins. thick at the center with a 1-in. crown. A 1:1½:3 mix was used.

The batch box, central proportioning method was used to supply the mixer, the batches being hauled from the loading plant on a 2 ft. gauge industrial railroad. The plant was set up in the middle of the job about a half mile south of the improvement and adjacent to a 42-car capacity spur track leading off the Grand Trunk Railroad. Gravel and sand were



PLANT LAYOUT FOR CONSTRUCTION OF F. A. ROAD PROJECT NO. 43, MUSKEGON COUNTY, MICHIGAN.



CONCRETING ON F. A. ROAD PROJECT NO. 43, MUSKEGON COUNTY, MICHIGAN.
Left: Mixing Plant and Batch Handling Crane, Note Bottom Dump Batch Box. Right: Battery of Finishing Machines Following 2-yd. Paver.

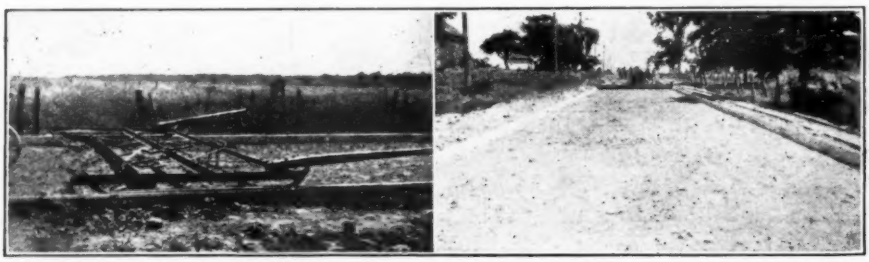
unloaded from gondolas with a 1-yd. clamshell operated by a gasoline-driven multipedal crane. This material was stocked over a batch charging tunnel 300 ft. in length. A 1-car capacity pocket was built under the spur track to permit unloading hopper bottom gondolas, the crane handling the material from the pocket.

Forty-eight chutes in the roof of the tunnel carried the gravel and sand by gravity, to the batch boxes. The boxes were divided into three compartments and dumped from the bottom. The middle compartment carried cement and was built of sheet iron with a water-proof cover, allowing trainloads of material to be stored adjacent to the work regardless of weather conditions. Each batch contained 10 sacks of cement, 15 cu. ft. of sand and 30 cu. ft. of gravel, approximately 2 cu. yds. of loose material.

The industrial equipment consisted of 250 batch boxes on cars, one 3-ton gasoline locomotive, seven 6-ton gasoline locomotives, and 11 miles of track. Five locomotives were used on the long hauls, one used in switching and one held in reserve. The 3-ton locomotive was used spotting cars in the tunnel. The size of trains depended largely on the grades, the maximum on Section A being 42 cars, and on Section B 24 cars. Trains were delivered near the mixer and the individual cars spotted with a team of horses.

The mixer used is one of the largest in the United States for paving work, and was built along lines suggested by Mr. Scharl. The capacity of the drum is 2 cu. yds. of loose material and it is operated with a gasoline motor. The drum is charged through a stationary hopper located at the top of the machine and the batches are dumped directly into this hopper, after having been raised into position by a gasoline multipedal crane. The multipedal is connected to the mixer truck with draw chains and moves the mixer forward as the work progresses. The crane method of handling the batches is very rapid of operation, as a batch is held in readiness to charge the drum as soon as the mixer is closed after discharge. A minimum of time is required to get the material into the drum on account of the hopper arrangement which makes the charging almost instantaneous. The crane may be detached from the mixer and used in other work.

Each batch was mixed for one minute and placed with boom and bucket on the subgrade with sufficient water content to make a workable batch. The concrete was spread and finished with two finishing machines. Previous experience showed that one machine could not satisfactorily handle the volume of concrete turned out by a paver of this size. The finished concrete was covered with earth



SUBGRADING OPERATIONS ON F. A. ROAD PROJECT NO. 43, MUSKEGON COUNTY, MICHIGAN.
Left: Subgrader Built on Job; Very Simple in Construction; Does Excellent Work in Light Soils. Right: Prepared Subgrade; Fine Grading Crew in Distance.

and cured with water for 14 days. The water supply came from creeks and was pumped to the job through 2½-in. pipe lines.

Most of the rough grading was done with a heavy duty grader hauled by a 20-ton tractor. The fine grading was done with a subgrader built on the job. The shouldering was finished with a crane and clam shell and a part of the ditching was also handled with the crane converted into a drag line to which was attached a large board scraper.

Paving in 1921 started April 25th at the west end of Section B and the seven miles were completed June 13th, making an average of one mile per week for seven weeks. The best record for one day was 1,340 lin. ft. of pavement in a continuous run of 11 hours, although runs of 1,000 to 1,200 lin. ft. were not uncommon. The workmanship both on the pavement and the shoulders is excellent. The west two miles of Section A were laid in 1921 with a smaller industrial outfit.

The work was done under the supervision of the Grand Rapids District Office of the State Highway Department and the field engineering was handled by the Muskegon County Engineer, who was employed by the State Highway Department as Resident ngineer.

DEVELOPING A LOCAL GRAVEL DEPOSIT FOR GRAVEL ROAD WORK

As a means of utilizing a gravel deposit adjacent to the job and saving the expense of hauling materials a distance of some 15 miles from the nearest commercial sand and gravel plant, the Ann Arbor Asphalt Construction Company is successfully employing a Sauerman power drag scraper system in connection with a 10-mile gravel road contract near Hamburg, Mich.

Several features are of especial interest. There are two 1 cu. yd. scrapers operated by one 35-H.P. double-drum steam hoist, which is unusual. When one scraper is discharging its load into the hopper at the gravel bin, the other scraper is at the far end of the pit digging another load.

A second uncommon feature of this installation is that the scrapers have carried the pit down to a depth of 50 ft., whereas this type of equipment, generally speaking, is not considered adaptable to deep digging, being designed chiefly for hillside excavation, stripping overburden and so forth. The accompanying illustration gives an idea of the long, steep incline up which the scrapers have to travel due to the depth of the excavation.

The gravel is excavated, screened and loaded into motor trucks with a minimum of labor. As the scrapers are of the bottomless type, they load and dump automatically, consequently no pit-men are required. One man operates the scrapers;

SHOWING INCLINE FROM GRAVEL PIT AND SAUERMAN SCRAPER DISCHARGING ITS LOAD THROUGH TRAP ONTO GRIZZLY.

a fireman and a man to watch the screen and the loading bin complete the crew. When a scraper reaches the top of the incline, its load of raw material drops through a trap onto a grizzly that takes out the over-size stones, then passes over a screen where the excess sand is removed and then flows into the storage bin, where the motor trucks are loaded.

Mr. Manley Osgood, president and manager of the Ann Arbor Asphalt Company, who is responsible for the installation, says it is a very economical, trouble-saving method of obtaining gravel for road construction purposes.

NEW PORTABLE MIXING PLANT FOR REPAIRING, RESURFACING AND LAYING BITUMINOUS PAVEMENTS

By Monroe L. Patzig, Consulting Engineer, Patzig Laboratories, 206-210 Eleventh St., Des Moines, Iowa.

To fill the need for a small Portable Asphalt Mixing Plant, that can be used economically by contractors or others for repairing sheet asphalt, asphaltic concrete, bitulithic and similar pavements, the plant described herein has been built by the New Monarch Machine and Stamping Co., of Des Moines, Iowa.

The plant was completed about the first of November, 1921, and has since that time proven itself capable of doing all that it was designed to do.

Its general principle is similar to the larger sized standard type asphalt mixing plants. A drum is used for heating the mineral aggregate, and a standard twin pug mixer for mixing the aggregate with the asphalt.

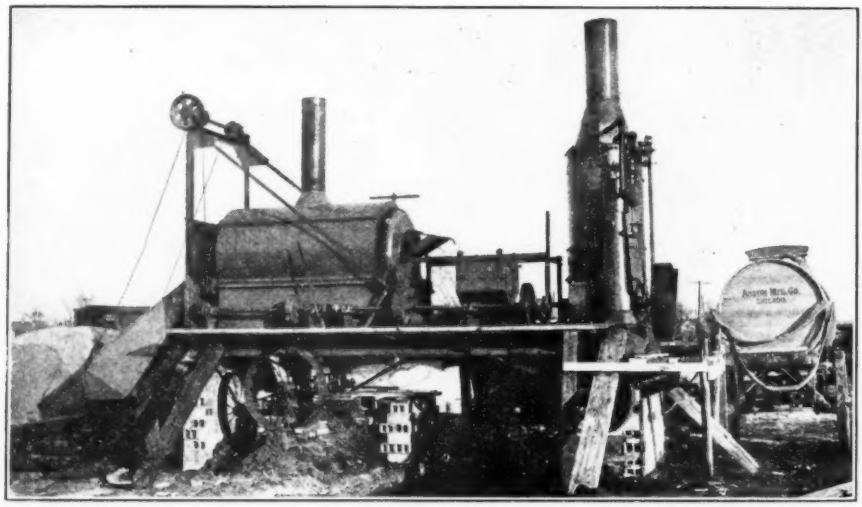
Certain features or operations of it, however, are quite different from those found in the larger types. For the purpose of eliminating excessive weight the plant was designed so the heating drum takes only one batch at a time. Mineral aggregate is taken from the various piles of different sized aggregate in the exact proportions necessary to secure the desired grading. These proportions make up a single batch which is dumped into the skip, thence hoisted and dumped into the drier drum.

The drum has an extra large grate area, the gases and heat come in contact with the lower side of the revolving drum and go up between the sides thereof and of the jacket surrounding it, to the smoke stack above. The interior of the drum is provided with spirals extending from the receiving end to within 18 ins. of the discharge end. At this end horizontal troughs are attached to the circumference of the drum and pick up the heated aggregate and drop it onto a discharge chute. A small hot sand bin receives the discharge from the drum and is then pushed along its track to a position over the mixer where it is discharged. Through the twin pug mixer the mixed material is dropped into the wagons in the usual manner. Asphalt can be dipped or pumped from the portable kettles as required.

While one batch is mixing, another batch is running through the heating drum and being delivered into the hot sand box, while a third batch is being put into the skip hoist.

A 6 cu. ft. twin pug mixer was used and batches varying between 400 and 550 lbs. were run through successfully.

A steam line from the boiler into the stack of the heating drum made it possible to regulate the heat as required very simply and easily. The time required for heating the batches of aggregate was about 3 minutes. Since the plant was designed for a 500 sq. yd. capacity of 2-in. wearing surface, and the materials were very wet and frozen at the time, it

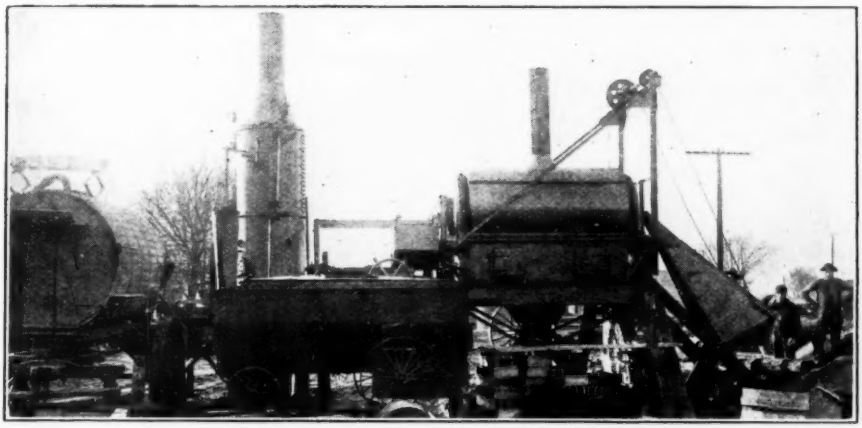


VIEW OF NEW PORTABLE MIXING PLANT FOR REPAIRING, RESURFACING AND LAYING BITUMINOUS PAVEMENTS.

was considered that the results accomplished were better than expected.

The 20 h. p. upright boiler and 15 h. p. vertical engine have also proven entirely satisfactory. Steam is also available for heating the pug mixer walls, draft for the heating drum and for agitating the kettles. A single shaft from the engine operates the mixer, heating drum and the skip hoist.

The first day's operation of this plant showed remarkable results although all men employed were inexperienced and more help was employed than was necessary.



ANOTHER VIEW OF NEW, SMALL SIZE, PORTABLE ASPHALT MIXING PLANT.

With 12 men at the plant, 2 teams hauling hot stuff, and 10 men on the street and a roller man, a 342 sq. yd. run of 2-in. asphaltic concrete for patchwork was made at a total cost for labor, materials, fuel, insurance, interest and depreciation, of 86c per sq. yd.

On the following days, more work was run out with four less laborers, thus reducing the above cost for a 500 sq. yd. run to 70c per sq. yd.

The temperatures of materials were exceptionally uniform and the analysis of the mixtures run showed perfect results.

The plant was designed by the writer with the intention of providing a plant that can successfully be used for small jobs of resurfacing or patchwork. For patchwork it will enable the contractor to furnish a mixture which is not injured by overheating or made of reheated materials mixed at some other point. The writer desired to secure a plant which would assure paving mixtures that are known to be manufactured according to specifications for original work.

The entire plant with all of the equipment required for patchwork or resurfacing work can be shipped on a single flat car and can be erected ready to run within a day after unloading.

COMPLETE LINE OF ELECTRIC, GASOLINE AND BELT DRIVEN HOISTS

The Pawling & Harnischfeger Co., of Milwaukee, has standardized a line of Contractors' Stationary Hoists. They are made in types for electric, gasoline and belt drive, in sizes ranging from 8-H.P., with 8x12-in. drum, up to 115-H.P., with 18x28-in. drum. The long experience of the Pawling & Harnischfeger Co. in building its own hoist drums, electric motors, controllers and brakes used on its traveling cranes and monorail hoists has been drawn upon in the development of the stationary hoist line.

The same high quality electrical apparatus as furnished on P. & H. electric traveling cranes and hoists is used on all P. & H. electrically driven contractors' hoists.

For the gasoline-driven hoists, motors of the types that have proven successful in P. & H. Gasoline Excavator Cranes, Trench Excavators, Gas Shovels and Dragline Excavators are used. These are in all cases of the heavy duty, 4-cylinder, vertical tractor type, with Bosch Magneto, Master Carburetors, Stewart Vacuum Systems and air cleaners. Automatic throttle governors are provided and conveniently located hand throttles.

The belt-driven types are similar except that the rear end of the bed frame is left off, and a large size driving pulley is provided on the side opposite the operator. The construction for all types is similar—the bed plates and side stands are of box and I-beam section design, with heavy cross-girders and bottom and top flanging. Plates are accurately planed and side-faced. Through bolts only are used and all holes are drilled in jigs and fixtures. All drum shafts are of high-grade carbon steel, turned and ground to exact size, giving a fully polished bearing for the drum bushings and side stands. Gears are made with cut teeth, and motor pinions and gears are hobbed. Drum gears are of solid web type, with large hubs pressed in place on the shafts by hydraulic pressure against a shoulder.

Contracts Awarded

ROADS AND STREETS

Ala., Mobile—Hancock Bros. awarded contract for constructing conc. road, Mobile Co. at $148,326.

Ala., Mobile—Hancock Bros. awarded contract by State Hwy. Dept., for constr. of Craft Hwy. connecting Mobile and Chickasha, at $50,000.

Ark., Morrilton—Morena-Burkman Co., St. Louis, Mo., awarded contr. for paving streets; conc. base 6 in. thick and 2 in. asph. top; conc. gutters and curbing, at $101,000.

Ariz., Phoenix—White & Miller, 1623 W. Washington St., Phoenix, awarded contract for impvt. of 7th St. at $2.70 per yd. Work involves 21,082 sq. yds. paving; 21,028 sq. yds. grading at 33c yd., 9,963 lin. ft. comb. cem. curb and gutter at $1.50 per ft.; 918.05 ft. curb at $1 ft.; 382 lin. ft. gutter at $1 ft.; 945 lin. ft. valley gutter at $1.50 ft. and minor items includ'g conc. and vit. pipe culverts, storm water manholes, gutter inlets and sheet iron irrigating gates.

Ca., Calexico—Lynn S. Atkinson, Chapman Bldg., Los Angeles, award. contract for grading and constructing cem. curb and walks, also cross walks on a large number of city streets at $269,495.

Cal., El Centro—H. H. Peterson, Loma Potal, San Diego, awarded contract at about $184,520 for paving with 5½-in. cem. conc. 5 sections of county hwy.

Cal., Los Angeles—California Constr. Co., San Francisco, awarded contract for paving with cem. conc. shoulders and a sph. conc. wearing surface 3.71 miles state hwy., Fresno Co.,—Selma to Kingsburg—at $37,739; Southwest Paving Co., 415 Washington Blvd., Los Angeles. awarded contract for surfacing with asph. conc., 7.04 miles state hwy. in Los Angeles Co., at $75,648.

Cal., Los Angeles—Fairchild-Gilmore-Wilton Co., Los Angeles Ry Bldg., awarded contract for paving Eagle Rock Ave. with cement conc. and constructing monolithic conc. and conc. pipe storm sewers, at $40,409.

Cal., Sacramento—Clark & Henery Constr. Co., Stockton, awarded contr. for surfacing with asph. conc. 7.85 miles state hwy. Santa Clara Co. betw. Morgan Hill and Gilroy, at $14.115; Southwest Paving Co., 415 Wash. Blvd., Los Angeles, awarded contract for paving with conc. shoulders and asph. wearing surface 8.4 miles state hwy., 2 sections Santa Barbara Co., at $92,884; Federal Constr. Co., San Francisco, awarded contract for surfacing with asph. conc. 2.3 miles in Fresno Co., at $28,493.

Cal., Sacramento—J. P. Holland, San Francisco, awarded contract for 12-mile graded section in Mendocino Co. at $170,239; Federal Constr. Co., San Francisco, awarded contr. for 2.27 mi. asph. conc. surfacing to be laid no. of Fresno, at $23,943.

Cal., Sacramento—J. P. Holland, San Francisco, awarded contract for grading 12 miles state hwy. in Mendocino County betw. Flynn Creek and mouth of Navarro River, at $170,239.

Cal., Santa Ana—Graham Bros. & Bruce, 321 E. 4th St., Long Beach, awarded contract by Co. Supvrs. at $32,112 for widening and bldg. concrete pavement on Garden Grove Ave. with concrete, at $32,112.

Cal., Santa Barbara—Fairchild-Gilmore-Wilton Co., Los Angeles Ry. Bldg., Los Angeles, awarded contract to constr. Surf-Lompoc Hwy. 29 miles in length, at $497,989; Hunter & Richardson, 525 E. Haley St., Santa Barbara, awarded contract for paving portions of Haley, Cota, Soledad and Casitas Sts. with 5-in. cement conc. base with 1½-in. asph. conc. top; comb. cem. curb and gutter, 8-in. and 6-in. vitr. pipe sewers, 76 4-in. house connection sewers, dry rubble walls, catch basins, at $55,136.

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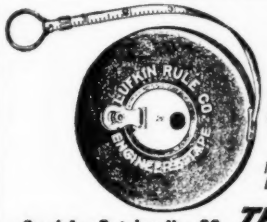

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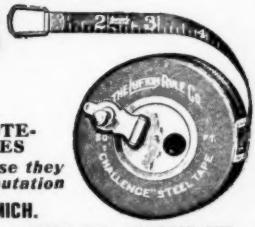

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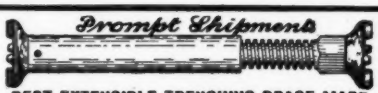

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Cal., Turlrock—A. Teichert & Son, awarded contract for paving Florence E. Olive, Myrtle, Merritt, Sycamore, Lander and First Sts., at $73,042.

Cal., Yuba City—Byrne & Most, Sacramento, awarded contract for constr. of concrete hwy. from Kirksville to Knights Landing—4½ miles, at $23,191; Chesson & Lilly, Marysville, awarded contr. to build Oswald lateral a dist. of little more than 2 miles, at $5,860.

Fla., Kissimmee—E. P. Maule awarded contract to complete Melbourne-St. Cloud-Kissimmee Rd. from Melbourne to Osceola Co. line, at $119,852.

Fla., Melbourne—Morgan Paving Co., Miami, Fla., awarded contract for 2½ miles paving, at $230,450—40 ft. and 20 ft. paving; waterbound macadam base course; bitum. penetration wearing surface or surface treatment and conc. curb.

Ia., Ames—W. W. Malkmus, Livermore, Ia., awarded contract for gravel surfacing approx. 4 miles Co. Rd. System, Humboldt Co., at 46c for gravel 1 mile haul and 6c for each unit of additional half-mile haul, 4,000 cu. yds. gravel, 1 mi. haul and 16,800 units additional half-mile haul; F. A. Engstrom, Renwick, Ia., awarded contract for graveling 2 miles Twp. Rd. Vernon Secondary Rd. Dist. No. 1; 1,600 cu. yds. gravel 1 mi. haul at 45c per cu. yd. and 1,500 units additional half-mile haul at 10c per munit; Following contracts let for road work in Winnebago Co. on Primary Rd. Proj. 120: Wm. Dutton, Boone, Ia., contract for 19,404 cu. yds. earth excav. at 32c per cu. yd., 2,312 cu. yds. earth excav. at 35c per cu. yd.; L. H. Marvill, Des Moines, 9,202 cu. yds. gravel, 1 mi. haul, at 38.7c per cu. yd., 57,720 units gravel ½-mi. haul at 10.4c per unit; 17,160 cu. yds. gravel 1 mile haul at 38c per cu. yd., 84,240 units gravel ½-mi. haul at 10c per unit.

Ia., Ames—Following contracts let by State Hwy. Dept.: C. R. Yegge, Boone, Ia., gravel surfacing roads in Dist. No. 29, Boone Co. Secondary Rd. Dist No. 29, gravel 1st mile haul at 29.9c per cu. yd. and 8c per unit for additional half-mile haul; Thos. Farrell, Jefferson, Ia., grading ½-mi. rd. in Kendrick Twp., at 37.5c per cu. yd.; grading and draining 6.84 mi. from Fairfield so. F. A. P. 120, Jefferson Co. C. L. Reis, Ottumwa, Ia., tile material and tile labor and Type "A" and "B" intakes; W. W. Cummings, Ottumwa, 81,144 cu. yds. earth excav. at 27c per cu. yd.; Scott Co. FAP 55, Sec. B. paving, draining and incidental work on Davenport-Harrison Street-New Liberty Rd.: David Wisely & Son, Sheffield, Ill., tile material; L.M. Harrison, Traer, Ia., tile labor and intakes; Scott Co., FAP 55, Sec. C, grading and draining 3.94 mi. Davenport-LeClaire Rd. from LeClaire southeast. E. D. Jenner, Davenport, Ia., earth excav. loose rock and solid rock; David Wisely & Son, Sheffield, tile material; Wm. Rathlef, Eldridge, Ia., tile labor and intakes; Scott Co. FAP 114, guard rail and baffle wall constr. on Davenport-New Liberty, Davenport-Mt. Joy and Davenport-Princeton Rds.: J. W. Ogle, Ames, guard rail constr. at 38c per lin. ft.; Pewick Constr. Co., Des Moines, baffle walls complete at $10.50 each; Scott Co., FAP 135, Sec. A, 2.947 mi. from McDonald's Crk. toward Clinton Co. line; Jas. J. Ryan, Muscatine, tile deliver; Wm. Rathlef, Eldredge, Ia., tile labor and Type B intakes.

Ia., Council Bluffs—E. A. Wickham Constr. Co., Council Bluffs, award. contract. for improving 43 miles county road. Work will start in spring.

Ia., Crowley—F. C. Barbour awarded contract for constr. of Herre relift road; gravel Sub-Rd. Dist. No. 2 plans rd. constr. 27 miles. $350,000 available.

La., New Orleans—J. D. Harvey & Co., Memphis, awarded contract for 23.8 miles Pershing Hwy., Jackson Parish, at $125,583.

Minn., Breckenridge—E. W. Coons Co., Hibbing, awarded contract for paving 7 blocks, 8th St., N. from Minn. Ave. to Bede Ave. and 5th St.—New York Ave. to Bede Ave., at $84,601.

Minn., Foley—McCree, Moos & Co., 711 Merchants Natl. Bank Bldg., St. Paul, awarded contr. for conc. paving on State Proj. 27-21, 23 miles long, at $244,811.

Minn., St. Paul—Following contracts let by State Hwy. Dept.: T. H. No. 10, Hancock-Clontarf, 9 mi. gravel surfacing, to Dobbelman & Rasmussen, Minneapolis, at $20,066; T. H. No. 28, Browns Valley eastward, 23.4 mi. gravel surfacing, to Scully & Connelly Cos., at $64,616.

Minn., St. Paul—Following contracts let for road work which includes 25 gravel-surfacing jobs totaling 260.57 miles at $467,336; 7 grading jobs on 86.10 miles with bridges and culverts included at $454,852—grand total on the 32 projects, $922,188: Geo. W. Kinney, Foley, T. H. No. 2, 6.2 mi., gravel surfacing at $8,539; G. H. Gatzenmeyer & Co., Minneapolis, T. H. 3, at $10,581; T. H. No. 5, 5 miles gravel surfacing to Morton & Bjerkness, Minneapolis, at $8,795; T. H. No. 7, 4.5 miles grading, Jack Brown, Madison Lake, grading, $14,501; Sublette and Dwyer, Minneapolis, mono-culvts,, $4,728; Elk River Conc. Products Co., Elk River, culvt. pipe, $875; T. H. Nos. 7 and 60, 11.3 mi. grav. surfacg. C. F. Scully Equipt. Co. and Connelly Constr. Co., St. Paul, $27,669; T. H. No. 8, 11.8 mi. gravel surfacing; Div. A to Northern Rd. Constr. Co., Minneapolis, at $19,897; Div. B to Floan & Sundstrom, So. Hibbing, at $7,564; T. H. No. 8, E. Grand Forks-Fisher, 15 mi. gravel surfacing to Peter Mortenson, Hibbing, at $14,246; T. H. No. 8 and 65, 15.7 mi. grading Windstron Bros., Minneapolis, $93,464; Schmitz & Mayer, Frazee, mono. culvts., $20,089; Minneapolis Bridge Co., Minneapolis, Culvt. pipe, $1,414; Gt. Northern Bridge Co., bridge, $4,500; T. H. No. 9, 5.1 mi. grading; A. Guthrie & Co., St. Paul, grading, $52,575; mono. culvts. $7,794 and 2 bridges, $12,410; Lylue Culvt. Co., Minneapolis, culvt. pipe, $446; T. H. No. 9, Jackson-Worthington, 8 mi. grav. surfacing, to G. H. Gatzenmeter & Co., Minneapolis, at $14,006; T. H. 10, 8.9 mi. gravel surfacing, to Chas. Weaver, Anoka, $11,346; T. H. 10, 12.2 mi. gravel surfacing, Chas. Weaver, Anoka, $17,867; T. H. 10, 9 miles gravel surfacing, to Dobbleman & Rasmussen, Minneapolis, at $20,066; T. H. No. 18, 4 miles gravel surfacing to Clusian & Lidberg, Grand Rapids, at $7,017; T. H. 18, 9.9 miles gravel surfacing, to Winston Bros., Minneapolis, at $16,733; T. H. No. 21, LeSueur Center to St. Henry, 11.0 miles, gravel surfacing, (2 contracts) to S. J. Peterson, Minneapolis, at $23,113; T. H. 23, 13.6 miles grading to Wilkins & Pettijohn, Park Rapids, at $33,910; Independent Bridge Co., Minneapolis, $3,790 for bridge; Gt. Northern Brdg. Co., Minneapolis, bridge, $6,500; Morris Constr. Co., Morris, mono. culverts, $9,786; Western Steel Products Co., Duluth, culvert pipe, $886; T. H. No. 23, Foley-Milaca, 15.6 miles grading; Wilkins & Pettijohn, Park Rapids, grading at $37,822. Milaca Bridge Co., Milaca, brdg., $7,390; mono-culvts., $8,918; Western Steel Products Co., Duluth, culvt. pipe, $2,156; T. H. 28, 11.8 mi. grading, Jurgenseon Constr. Co., Summit, S. D., grading, $44,186; Morris Constr. Co., Morris, mono-culvts., $13,724; Klauer Mfg. Co., Dubuque, Ia., culvt. pipe, $886; T. H. 28, Swanville-Sauk Center, 16 miles gravel surfacing, Campbell Constr. Co., Minneapolis, at $17,634, 2.9 mi. gravel surfacing, Dobbleman & Rasmussen, Minneapolis, at $2,795; Browns Valley eastward, 23.4 mi. gravel surfacing to Scully & Connelly Cos., at $64,616; 4 miles gravel surfacing, to Scully & Connelly Companies at $3,239; T. H. No. 30, Bijou-Waubun, 18 mi. gravel surfacing to Dobbleman & Rasmussen, Minneapolis, at $41,067; T. H. 34. 5.47 miles gravel surfacing, to Dobbleman & Rasmussen, Minneapolis, at $17,800. T. H. 34, 5.47 miles gravel surfacing to Wilkins & Pettijohn, Minneapolis, at $9,546; T. H. 35, 8 miles gravel surfacing, Campbell Equit. Co., Minneapolis, at $12,395; No. 35, 9.8 miles, grading, Winston Bros. Minneapolis, grading, $54,478; Roach Constr. Co., Gaylord, monoculverts, $16,743; Western Steel Products Co., Duluth, culvert pipe, $591.15; No. 35, 7.5 miles gravel surfacing to Day Bros., Minneapolis, at $14,579; No. 54, 12 miles graved surfacing to Frank Goergen, Wheaton, at $12,531; No. 68, 17 miles gravel surfacing to F. C. Mitchell & Co., Rochester, at $28,849.

Mo., Jefferson City—Following contracts let by State Hwy. Dept.: C. W. Dillingham, St. Joseph, Mo., awarded contract for constr. of 1.804 miles State Rd. east and west thru Livingston Co., at $24,722; Kerby A. Raines, Fayette, Mo., contract for constructing 4.157 miles State Rd. from Ashland to Jefferson City, at $17,196; Norman Davis, Sikeston, Mo., contr. for grading, culverts, bridges, gravel pavements, etc., on 8.976 miles State Rd. east and west of Dexter, at $59,810; R. A. Ross, Kans. City, Mo., contract for constructing 7.94 miles State road no. and so. thru La Grange Special Rd. Dist. Lewis Co., FAP 39, at $83,465.

Mo., St. Louis—Unit Constr. Co., St. Louis, awarded contract for emay Ferry Rd., at $243,981.

Contract calls for bldg. 7.3 miles 18 to 20 ft road southward from Telegraph Rd.; Whitlow Constr. Co., Charles City, Ia., contract for Gravois Rd. 6.7 miles 20 ft. rd. FAP 78, at $192,208.

Mo., Sikeston—Norman Davis, Sikeston, awarded contract for bldg. state road 8.976 miles long, east and west of this city, (Dexter), at $559,810. Work includes grading, constr. of culverts, bridges, riprap and gravel pavement 16 ft. wide.

Minn., Wadena—Campbell Constr. Co., 3050 Hennepin Ave., Minneapolis, awarded contract for approx. 16,391 sq. yds. pavement at $49,719.

Neb., Kearney—Peterson, Shirley & Gunther, 1102 W. O. W. Bldg., Omaha, for graveling Proj. 127, at $65,015.

Neb., Lexington—Peterson, Shirley & Gunther, 1102 W. O. W. Bldg., Omaha, awarded contract for grav. surf. Overton-Cozad Rd., at 37½c, or total of $47,150.

Neb., Lincoln—Shirley & Gunther, Omaha, awarded contract for graveling 30 miles Nebraska roads; 12 in Dawson and 18 in Buffalo Co., at $112,166.

Neb., Omaha—E. A. Wickham, Council Bluffs, awarded contract for impvt. of west ends of Lincoln Hwy. River-to-River Rd. Pioneer Trail and White Pole Rd., at $300,000.

N. Y., Albany—Michael H. Ripton, Rochester, awarded contract for construction of Cherry Valley-Sharon Springs-Canajoharie Rd., at $339,262; A. F. McConville, Ogdensburg, awarded contract for constr. of Grand Gorge-Breakabeen Rd., Schoharie Co., at $159,550; Schunemunk Constr Co., Highland Falls, awarded contract for constr. of Montelo-Grahamsville Rd., at $81,000.

N. Y., Au Sable Forks—Antonio Barboni, Syracuse, awarded contract to constr. Ticonderoga Rd., 8.02 miles in length, at $250,601.

N.C., Monroe—Redmon Construction Co., Monroe, awarded contract for Proj. 695 in Union Co., at $112,604—4.51 miles hard surf. Topeka pavement.

N. C., Shelby—Southern Paving Co., Chattanooga, Tenn., awarded contr. for Proj. 823, Cleveland Co., involving 1.90 miles hard surface rd. on Route 206, at $54,814.

N. C., Williamston—J. P. Dicus, Burgaw, awarded contract for Proj. 155, Martin and Pitt Counties on Route 90 from Williamston to Bethel, involving 19.31 miles of grading and surfacing, at $58,784.

N. C., Wilson—P. R. Ashby, Raleigh, awarded contract for Proj. 291, involving 7.63 miles hard surface road in Wilson Co. on Route No. 40, at $184,993.

N. C., Winston-Salem—Atlantic Bitulithic Co. awarded contract for street paving here during ensuing year which will include 150,000 to 200,000 yards.

Tex., Brenham—Walling & Haralson, Houston, awarded contract for paving, at $95,000.

Tex., Cuero—Hutto & Son, Gonzales, Tex., awarded contract to construct 10.31 miles gravel road and build conc. bridges, at $72,000.

Tex., Dallas—Texas Bitulithic Co. awarded contract for paving of Preston Rd.—Wycliff Ave. to Beverly Dr.—at approx. $190,000.

Tex., Sherman—T. J. Larkin & Sons, Dallas, awarded contract by Grayson Co. Commrs. Court for constr. of almost $500,000 worth of gravel roads in Grayson Co. Roads are to be built in following three districts in the county: Gunter, $190,000; Howe, $150,000, and Southmayd, $99,000.

Olympia, Wash—State Hwy. Comn. let following contracts: Clearg. gradg. draing. and surfacg. with crushed rock about 3.0 mi. Navy Rd. Hwy. betw. Tidewater Crk. and Charleston, Kipsap Co., to Fred Morgan, Buckley, at $79,584; Hans Pederson, Seattle, contr. for similar wk. but surfacing with gravel, abt. 3.1 mi. North Bank Hwy. Skamania Co., at $54,538; Voyle & Lindsay, Stevenson, awarded contract for surfacing with gravel about 1.0 miles No. Bank Hwy. from Stevenson west in Skamania Co. Posy Rd. Proj. 86, at $3,837; Pincella & Yelero, Naselle, contr. for clearg. gradg. and draing, abt. 2.0 miles Ocean Beach Hwy. bet. Nasel and Johnson's Landing. Pacific Co., at $26,138; Reinseth & Co., Everett, contr. for similar work and surfacing with gravel abt. 9 miles Olympia Hwy. betw. Beaver and Forks, Clallam Co., at $70,752.

Wn., Seattle—Olympia Construction Co., 1326 Northlake Ave., awarded contract for grading, paving, etc., at $324,604; C. L. Creelman, 1079 25th Ave. N., awarded contract for grading on 48th Ave. S. W. et al, at $20,833.

W. Va., Charleston—Road contracts aggregating more than half a million dollars awarded by State Road Comn., as follows: Greenbrier Co. Crawley-Clintonville Rd., 3 miles, to Joe Carola, Ronceverte, at $21,260; Boone Co., Danville-Peytona Rd., 4.6 miles, to L. J. Chandler Co., Virgilina, Va., at $71,034; Pocahontas Co., Huntersville-Knapps Crk. Rd., 4 miles, to L. J. Chandler Co., Virgilina, at $36,713; Monongalia Co., Morgantown-Pt. Marion Rd. 5 miles, to Keeley Constr. Co., Clarksburg, at $48,298; Jackson Co., Ripley-Fairplain Rd., 2 miles, Keeley Constr. Co., Clarksburg, at $62,516; Marshall Co., Moundsville-Taylor's Ridge Rd., 2 miles, to Stringer & Springer, Moundsville, at $42,000; Calhoun Co., Grantsville-Arnoldsburg Rd., 3 miles, Cavin & Powers, Charleston, at $43,825; Grant Co., Pendleton Co. line to Pansy Rd., 4.4 miles, H. N. Schilesley, Johnstown, Pa., $41,220; Morgan Co. Berkeley Springs-Hancock Rd. 3.3 miles, Souder Constr. Co., Lancaster, Pa., at $86,279; Cabell & Wayne Cos., Huntington-Hodge Crk. Rd., 4.5 miles, Keeley Constr. Co., Clarksburg, $129,852.

SEWERAGE AND SEWAGE TREATMENT.

Ala., Fort Payne—Coker, Gamble & Brown, Chattanooga, Tenn., awarded contract to constr. san. sewers, pave walks, etc., at $27,000.

Cal., E. San Diego—Hickey & Harmon, San Francisco, awarded contract for constr. of approx. 30 miles of lateral sewers in East San Diego, at about $232,000.

Cal., Santa Ana—B. R. Ford, Santa Ana, awarded contr. for constr. of vit. pipe sewer in Greenleaf Ave. and other streets involving 2,485 ft. 8-in. pipe at 80c ft; 2,820 ft. 6-in. pipe at 70c ft.; 5 manholes at $100 each; 2 flush tanks at $110 each and 2 lampholes at $15 each.

Cal., Taft—Harron & Hayes, 259 15th Ave., San Francisco, awarded contract for constr. reinf. conc. septic tank for city at $14,888.

Ont., Dunnville—Webster Constr. Co., Ltd., Bank of Toronto Bldg., London, awarded contract for sewers at $8,810.

Ont., Hamilton—J. D. Armstrong, 871 Main St., E. awarded general contract for constr. of sewers on Proctor Blvd., Main St. and alley for City, at $8,500.

Que., Montreal—A. Di Cesar & Co., 885 St. Catherine St. E. awarded contract for constr. of sewer at $23,110 on Harvard Ave. from Monkland Ave. to Cote St. Luke Rd., also contr. for constr. of sewer on Coronation St., at $8,643; C. Perluzzi, 26 Sevignac Lane, contr. for sewer constr. on Berri St. Blvd. at $5770.

Que., St. Lambert—Messrs. Leger, 76A Aird Ave. and Tardif, 60 Adams St., Montreal, awarded general contract for san. sewers, at $15,000.

Fla., Dunedin—Jas. G. Yeats Co., Port Tampa City, Fla., awarded contract to extend sewer system at $16,873; constr. 6, 8 and 10-in, san. and 12 and 15 in. storm inlets; including manholes, flush tank and disp. plant. Geo. S. Iredell, Engr., 316½ Franklin St., Tampa.

Fla., West Palm Beach—J. C. Mishler, awarded contract for constr. of sanitary sewer in district No. 2, at $60,337.

Ida., Boise—Morrison & Knudson, awarded contr. for constr. of north side drain sewer system.

Ill., Dixon—American Plumb. and Heating Co., E. St. Louis, awarded contract for constr. of sewer on Fifth and Sixth Sts. on Diron Ave., at $4.180.

Ill., Mt. Olive—John Keeley Co., E. St. Louis, awarded contract by Bd. Local Impvts. for constr. of sewer at $82,400.

Ind., Indianapolis—Following contracts let by Bd. of San. Commrs.: Scott Elec Co., City, Contract for switchbd., elec. wiring, equipt. and conduits, at $4,389; 4 motors to Dravo-Doyle Co., Pittsburgh at $2,300 and 2 centrif. pumps, Midwest Engine Co., at $1,776; screen drive from Chain Belt Co., Milwaukee, at $2,650.

Mass., Boston—Jas. Barletta awarded contract for sewerage works in Public Alley 817, from Gainsborough St. 370 ft. westerly, Roxbury, at $6,053.

Mo., Kansas City—Halpin-Boyle awarded contract to construct sewer within the boundaries of 65th and 72nd Sts. and Oak and W. Pennway Ave., at $16,985.

Mont., Livingston—McLaughlin & O'Neil, Livingston, awarded contract for constr. of storm sewers in Special Impvt. Dist. 101. Approx. 212

lin. ft. 8-in. pipe for inlets; 1,367 lin. ft. 8 to 30-in. ft.; 4 conc. manholes; 10 inlets with catch basins, also for paving and appurtenances, at $34,000.

Neb., Omaha—J. J. Hanighen Co., 617 S. 14th Omaha, awarded contract for constr. of sewer from 19th and Pierce Sts to 16th and Mason Sts. thru tract whereon C. R. I. & Pacific R. R. Co. will build freight terminals, at $26,499.

N. C., Elizabeth City—A. H. Guion & Co., Gastonia, N. C., awarded contract by Bldg. Comm., St. Normal Sch. for Colored, to install sewer and water systems, at $18,000.

Pa., Philadelphia—Jos. Lombardi, awarded contract for sewer constr. in sections of 3 streets, at $90,000; also contract for constr. of branch sewer on Kensington Ave., at $23,000.

Tex., Beaumont—Howard Kenyon Dredging Co. Houston, awarded contract to construct storm sewers in western section; 15,000 cu. ft. 4 to 7x8 ft. conc. storm sewers; install 4 draing. mains on Wiess Ave. 8th St. Carley Ave., etc., at $261,967.

Tex., Houston—H. A. Kipp awarded contract for constr. of sewer on Yuon St., at $1,839; Kroeger & Hayner, San Antonio, awarded contr. for constr. of sewer on Pease Ave., at $5,642.

Utah, Salt L. City—John O'Connor Co., Fargo, N. D., awarded contr. for constr. of sewer system at $100,000.

Va., Richmond—Claiborne & Taylor, awarded contract to construct Canal Run sewer sections Nos. 1, 2 and 3, Brookland Park Blvd. sewer at $63,000; Fulton Dist. sewer, at $11,000; C. M. Henley, at $22,000 to constr. Oak Grove sewer, sects. 1 and 2. Canal Run sewer will cost $83,000.

Wn., Spokane—Miracle Concrete Constr. Co., Great Falls, Mont., awarded contract for constr. of downtown sewer at $318,000.

Wis., Shullsburg—Gray-Robinson Constr. Co., Manitowoc, awarded contract for san. sewers at $15,000.

WATER SUPPLY AND PURIFICATION.

Cal., Anaheim—U. S. Cast Iron Pipe & Foundry Co. awarded contract for 672 ft. 12-in., 11,216 ft. 10-in. and 400 ft. 6-in. Cl. C cast iron pipe at $46.65 ton for pipe and average of $20.12 each for fittings, f. o. b. Anaheim.

Cal., Los Angeles—The Crane Co. awarded contract for furnishing 2,200 ft. 4-in. black dipped wrought iron pipe at $51.40 per 100 ft. immediate delivery; also contr. for 7,000 ft. 2-in. black dipped wronght iron pipe at $14.75 per 100 ft.

Cal., Los Angeles—Lacy Mfg. Co. awarded contract for riveted steel tank for Bd. Pub. Service, at $8,500.

B. C., Saanich—Yarrow's, Ltd., awarded contract conditionally by Council, for material necessary for constr. of Gordon Head water extension, at $69,720; Marine Iron Wks. awarded contract for 50 hydrants at $46 each. First named contract also included piping and special castings.

B. C., Sumas—Canadian Fairbanks-Morse Co., Ltd., 1400 Broad St., Victoria, awarded contract for installation of pumping costing $16,000 for Sumas Dyking District.

B. C., Vancouver—Vulcan Iron Works awarded contract for supplying city with 2,000 ft. 32-in. and 33-in. pipe, at $7.82 for larger and $6.13 for the smaller size.

Ill., Rockford—Sword Bros. awarded contract for air lift suction pump for new water works, at $7,441; also contract for valves for discharge at suction line, at $3,112; U. S. Cast Iron Pipe & Foundry Co., Chicago, awarded contract for furnishing pipe and fittings at $5,100.

Ia., Davenport—McCarthy Well Co., local, awarded contract for drilling artesian well, at $9,310. Well will be at least 1,650 ft. deep with 12-in. top graduating downward to 8 inches in diam. It will be lined with iron pipe.

Miss., Natchez—Corless Well & Supply Co., Memphis, Tenn., awarded contract for drilling well to supply plant; ultimate capy. 200,000 gals. water. Foundation started for turbine, 1,000 additional h. p. Contr. awarded by National Box Co., (Robt. Perry, Res. Mgr.)

Neb., Lincoln—A. A. Dobson Co., 809 1st Natl. Bk., Lincoln, awarded contract for water mains on South St.—Jefferson Ave. to 60th St., Normal Addn. Abt. 2¼ miles long. Wk. just started, $20,000.

Neb., Page—Following contract let for machinery and pumphouse for water works system: Engine, to Townsend Bros., Page; Pump complete, to Keystone Driller Co., 53 W. Jackson, Chicago, Ill.

N. C., Elizabeth City—A. H. Guion & Co., Gastonia, N. C., awarded contract by Bldg. Comm. of State Normal Sch. for Colored, to install water and sewers systems, at $18,000.

Tex., Newcastle—Groves & Young awarded contract to construct 90-ft. conc. spillway for dam. City will constr. filtr. plant.

Va., Staunton—DeLaval Steam Turbine Co., Trenton, N. J., awarded contract for pump for water works, at $3,600.

Prospective Work

ROADS AND STREETS.

Cal., Pomona—City plans to expend about $200,000 for approx. 14 miles of city street impvt. Streets in business section of city will be first to be paved.

Cal., Sacramento—At joint meeting of representatives of Utah, Nevada, California Hwy. Assn. the Victory Hwy. Assn. and Good Rds. Comm. of local Chamber of Com. decided that the Association would make a drive for $150,000, starting immediately after the 1st of year, for constructing road across northern portion of Nevada in those districts where ther are not enough people to supply funds necessary in order to receive federal aid. $15,000 of the amount will be used for purchasing, equipping and paying expenses of a maint. truck to keep rd. in Nevada open throughout the year.

Colo., Denver—State will expend $1,215,420 for maintenance of 7,316 miles of roads. Colorado counties will contribute $607,710 of total. In addition state will set aside $100,000 to meet emergencies.

Del., Dover—State Hwy. Dept. announces construction program of $2,250,000 for 1922. First contract letting last of February. C. D. Buck, Chf. Engr.; I. Paul Jones, Secy.

Fla., Titusville—State Road Dept., Tallahassee, Fla., authorized $300,000 for road constr. and bldg. brdg. $600,000 available. N. T. Froscher, Co. Clk., Circuit Court.

Fla., Madison—Madison Co. will hard surface 60 miles and sand-clay 153 miles hwys. $750,000 bonds voted.

Idaho—Lewiston—Nez Perce Co. Commrs. ordered that county furnish its proportionate share, in conjunction with state and fed. hwy. departments, for bldg. part of North and South state hwy. from west line of Evergreen Hwy. Dist. near Winchester down hill to Culdesac about 12 miles, at est. cost of $440,000. Nez Perce County's share is $73,333 or one-sixth.

Ida., Nampa—Another special election may be called to vote on bonds for purpose of improving various streets by surfacing, graveling and draining. Petitions also call for paving of about 20 blks. of streets of city.

Ill., Bloomington—City plans expendt. of $339,000 for public impvts. pavements, sewers, water mains, etc., included.

Ill., Champaign—City making plans for paving W. Clark St. with concrete, $30,000. F. C. Lohman, City Hall, Engr.

Ill., Waukegan—Lake County making plans for bit. conc. pavement 5 mile rd. west from Gurnee, 18 ft. $150,000; 2.5 mile rd. from Highland Park to Deerfield, 24 ft. $75,000; 2.5 mile rd. from Highwood west to Telegraph Rd., 18-ft. $75,000. C. M. Powell, Waukegan, Engr.

Kans., Topeka—New hwy. sys. for state has been worked out by State Hwy. Comn. State Comn. will receive $2,000,000 additional for rd. bldg.

Mich., Lansing—Program for road constr. by State Hwy. Dept. in 1922 is as follows: one course gravel or stamp sand, 135.0 mi.; gravel, 391.83 1/3 mi.; stone gravel, 2.5 mi.; macadam, 44.1 mi.; bitum. mac. 2.4 mi.; penertation 13.0 mi., conc. 241.9 mi.; brick 0.33 1/3 mi., grading and draing. structs. 95.75 mi.—total 926.91 2/3 miles. Leslie H. Belknap, Deputy St. Hwy. Commr.

Minn., Duluth—Will soon ask bids for 3 paving

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Loader and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Pullers, Electric.
Mead-Morrison Mfg. Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

contracts contemp. for 1922. Superior Street—8th Ave. W. to 3rd Ave. E. Est. cost $185,118 (brk. to be used); Woodland Ave.—Oxford to Austin Sts. conc. surface. Est. cost $100,000. Roosevelt St.—51st to 59th Ave. W. Est. $73,000. J. A. Farrell, Commr.

Miss., Moss Point—Plans under way for immediate constr. of hard surfaced road from east end of Tarvia road in Moss Point to plant of Southern Paper Co. by mayor and bd. of aldermen. Route covers abt. 2 miles. Surfacing material will probably be slag treated with Tarvia.

Neb., Lincoln—Two ordinances introduced for first reading which, if passed, will authorize issuance of $115,280 paving bonds.

Neb., Lincoln—State made offer to Lancaster County Board to build 10 mile stretch of gravel road in Lancaster Co. at cost. Co. Commrs. and Co. Engr. in favor of proposition. Geo. Leonard, Asst. State Engr., and E. H. Morey, St. Supt. of Rds. & Bridges.

Okla., Ardmore—Carter County has voted $500,000 for constr. of hard surfaced roads and R. J. Edwards, Ardmore, is preparing plans for the work. As soon as approved by Hwy. Dept. bids will be asked.

Okla., Fairfax—V. V. Long & Co., preparing prelim. plans for 90,000 sq. yds. paving. Est. cost $530,000. E. C. Quigley, City Clk.

Okla., Okla.—Word has been received by E. B. Clark, State Hwy. Commr. that the Secy. of Agricult. has approved state hwy. proj. No. 40, McCurtain Co. Project is approx. 70 miles in length extending from Idabel thru Broken Bow and Eagletown to Ark. line. It is to be built of gravel. As soon as plans are returned from Washington bids will be advertised.

S. D., Sioux Falls—Minnehaha Co. making plans for 1922 road program which includes 35 miles grading and graveling on Wash. Hwy.

Tex., Tyler—Proceeds from sale of Smith Co. Rd. bonds, amounting to $300,000, have been received by local banks and money together with $100,000 Fed. aid, will be used in bldg. Jim Hogg Hwy. thru County from Wood Co. to Cherokee Co. lines. Actual work will begin very soon.

Wn., Chehalis—Lewis Co. Commrs. have set aside $50,000 to be used co-operatively with fed. aid and state funds in constr. of Ocean Beach Hwy. from Chehalis to Adna for 4.5 miles.

Wn., Seattle—Douglas County Engr. Wm. H. Long reports following as important road work calendared for 1922 by Bd. of Douglas Co. Commrs.: 1—Sunset Hwy. Sec. 3, resurfacing with crushed rock approx. 3 miles, Beard to Grant Co. line. Approx. cost $4,000; (2) Dyer Hill Hwy. surfacing with crushed rock 3.1 miles. Approx. cost $11,000; (3) Perm. hwy. No. 10, grading, draining and surfacing with crushed rock or gravel 9.1 miles Mansfield to Bridgeport. Approx. cost $65,000—Total approx. cost, $80,000.

Wn., Vancouver—Co. Commrs. have ordered impvt. of road by laying concrete 18 ft. wide along St. Johns River from city limits 3 miles to Tracy Rd. Est. cost $75,000.

Wis., Appleton—Outagamie Co. Board has appropriated $20,000 for purch. of small tools and equipt. for co. garage and mach. shed, $93,924 voted for county aid road work in 1922. G. Brusewitz, Appleton, Commr.

Wis., Kenosha—Kenosha Co. Bd. has appropriated $20,000 for purch. of road machy. for 1922, including one truck, large grader and cement mixer. Jno. F. Herzog, Kenosha, Commr. Kenosha County Board has voted $165,000 bonds for impvt. of 18 ft. conc. (Geneva) Road, town of Salem—5½ miles.
Road, town of Salem—5½ miles. Jno. F. Herzog.

Wis., Madison—Dane County Board has voted state aid road constr. program for 1922 of $124,828. E. J. Smith, Madison, Commr.

Wis., Manitowoc—Manitowoc Co. has appropriated $19,000 for purch. of road machinery, including two tractors, two trucks, three small graders. Jos. Connell, Manitowoc, Commr.

Wis., Milwaukee—Milwaukee Co. Board voted county and state aid rd. constr. program for 1922 of $377,860. W. F. Cavanaugh, Pereles Bldg., Milwaukee.

Wis., Milwaukee—Contemplate constr. of 30-mile driveway around Milwaukee and connect all Milwaukee parks and suburbs. Plans of Co. Park Comn. C. B. Whitnall, Secy.

Wis., Port Washington—Ozaukee Co. Bd. has appropriated $10,000 for purchase of road machy. for 1922. W. J. Ubbink, Pt. Washington, Commr. County has also adopted state aid and co. bond issue to constr. rds. for 1922 of $117,813.

Wis., Sheboygan—Sheboygan County Bd. has appropriated $30,000 for purch. of new machy. for 1922 and $20,000 for purch. of road oil. Geo. W. Ubbelohde, Sheboygan, Commr.

Wis., Superior—Douglas Co. Bd. passed state aid bond issue for road constr. program for 1922 of $368,195. Conrad Hanson, Superior, Wis., Commr.

Wis., Waukesha—Waukesha Co. Bd. adopted county and state aid road constr. program for 1922 amounting to $1,369,561. Chas. J. Hann, Waukesha, Commr.

Wis., West Bend—Washington County board adopted state aid and co. bond issue for oad constr. program of $329,344.

Wis., Wisconsin Rapids—Wood County Board adopted state aid and county bond issue for road constr. amounting to $936,521. Ed. Morris, Wisc. Rapids, Commr.

Wisconsin—Rd. machy.: Waunpaca County Bd. has appropriated $20,000 for purch. of rd. machy. for 1922. Jno. Huffcut, Commr, Waupaca; Calumet Co. Bd., $4,000. Wm. Hoenig, Chilton, Commr.; Monroe Co. Bd. $10,000. Chas. H. Millard, Sparta, Commr.; Sauk Co. Bd. $40,000 for rd. machy. which includes 2 crushers, tractor and small graders. E. H. Groth, Baraboo, Commr.; Waukesha Co. Bd., $16,400 for rd. machy. Chas. J. Hahn, Waukesha, Commr.; Green Co. Bd. $85,000 for rd. machy. and $111,443.03 for road constr. program. Chas. J. Smith, Commr. Monroe; Langlade Co. Bd., $10,000. Chas. Olsen, Antigo, Commr.; Burnett Co. Bd. $1,000 for rd. machy., including patrol graders and gravel loaders. Geo. E. Miller, Webster, Commr.; Dodge Co. Bd. $5,000 for rd. machy., including crushing outfit. E. T. King, Juneau, Commr.

SEWERAGE AND SEWAGE TREATMENT

Md., Catonsville—Baltimore Co. Commrs., Towson, Md. considering installing sewer system, $700,000 to $800,000.

Minn., Deer River—Village will install sewer system from south end of 2nd St. in Easttown to Taylor Ave. on 1st St. N. with outlet in Deer River. W. S. Runyon, City Clk. Est. cost $38,000.

Minn., Virginia—Will call for bids for san. sewer extending 1,670 feet from hosp. to Williams Addn., $24,661; also for enlarging sludge beds at purification plant, $7,500. City Engr. E. F. Johnson; Elmer Matheson, Chrmn. St. & Alley Comn.

N. C., Hamlet—City plans expending $80,000 to install sanitary sewers, pave streets, etc.

N. C., Southern Pines—City will improve sewer and water systems; plans issuing $25,000 bonds. Gilbert White, Engr. Durham.

N. D., Carrington—Will call for bids in spring for sewage disposal plant. Cons. Engr. L. P. Wolff, 1001 Guardian Life Bldg., St. Paul, made plans. C. C. Carnahan, City Clk.

Okla., Watonga—$20,000 san. sewer system bonds have been issued here.

Pa., Beaverdale—Plans under way for installation of modern sanitary sewerage system in town. H. H. Griffith, Conemaugh, Pa. is head of movement and State Health Officer of this Dist.

Pa., New Castle—Petition of So. First St. residents in 7th Ward for san. sewer, presented to Council. City solicitor instructed to draw up Ord. to get work under way.

Tenn., Memphis—City will construct sewers in Randolph Subdiv. C. C. Pashby, Clk. Rowlett Paine, Mayor.

Tex., Amarillo—Work will soon start on extension of san. sewer system. $60,000 bonds voted.

Tex., Robstown—Plans being prepared for installation of modern sewerage system and disposal plant. $60,000 to $100,000 will be voted on by citizens. E. E. Sands, Houston, Engr.

WATER SUPPLY AND PURIFICATION

Ala., Geneva—J. H. Hardaway, Columbus, Ga., proposes erecting dam at Chalkers Bluff; Geneva Co.; 30 ft. high, developing 1600 to 1800 minimum H. P.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machine Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros Co.

Paving Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Cach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Ark., Conway—Report filed with City Council showing est. cost of impvts. to water system. Work will include replacing wooden water mains with ron mains. E. V. Sharp City Council and for tha iron mains. E. V. Leverett, Supt. of Water Wks.

Ark., England—Town Council has passed Ord. providing for impvt. of water works system. Work will include additional well, laying water mains and installing fire hydrants. J. R. England, Mayor; Tom Swain, City Clerk.

Ark., Ft. Smith—City (Fagan Bourland, Mayor) plans to constr. dams across Poteau River above Mill Creek.

Cal., Los Angeles—Fred A. Ballin, Portland, Ore. (shipbuilder) will construct giant pipeline proj. 75 miles in length extending from Bakersfield to Monolith. Project will be unique in Calif. engrg. records. It will require 8 months to complete and will cost betw. $500,000 and $1,000,000 according to prelim. estimates.

Man., Brandon—City Council has decided to proceed with constr. of sewers and water mains in northern end of City. H. Brown, City. Clk.

Ont., London—City will construct aerator and settling basin costing $10,000 on Horton Street. E. V. Buchanan, Mgr. Utilities Comn.

Ont., Ottawa—Bd. of Control recommended to City Council the installation of water mains in territory bounded by Nolland Ave., city limits, Spencer St. and Scott. Est. cost of work $42,325.

Ont., Petrolea—Citizens voted in favor of by-law of $40,000 for electrification of the pumping station at Lake Huron, using hydro-power and bldg. reservoir.

Del., Holly Oak—Holly Oak and Gwynhurst Dists. plan installation of water system.

Fla., Crescent City—Town will install water works and erect electric plant addn.; constr. 60,000-gal. conical tank on tower 100 ft. to bottom of tank; lay 13,000 ft. 6-in. cast iron mains and 1700 ft. 8-in. mains with necessary fittings; 31 two-way hydrants. $40,000 bonds. A. B. Harbison, Chrmn. Board Trustees.

Fla., Sebring—City will purchase water works. Will issue $100,000 bonds.

Ga., Atlanta—City expects to spend $1,800,000 for water works improvements during 1922. City will provide 21,000,000 gal. daily capy. filter basin and 10,000,000-gal. capy. clear water basin.

Ga., Milledgeville—City has acquired water works and will reconstr. Will install filter system. J. B. McCrary Engrg. Co. Engrs., Atlanta.

Ga., Valdosta—F. E. Hatch, Albany, Ga., will develop hydro-electric power on property known as Banks Mill Pond.

Ill., Lyons—City proposes constructing reservoir, pumping station and 4-6-in. cast iron mains. About $40,000. E. Hancock, 2047 Ogden Ave., Chicago, Cons. Engr.

Ia., Oskaloosa—City will get new water supply from Des Moines river, 7 mile pipe line, filtr. plant. Engrs. Burns & McDonnell, Interstate Bldg., Kans. City. Mo., to make estimates. T. H. Carlin, City Clerk.

Ia., Storm Lake—Plans under way for water works impvts., which include 250,000-gal. elev-steel tank, 100 ft. steel tower, duplicate pump units 400 gal. per min. each, new intakes, impvt. of filtr. units. Cons. Engr. W. E. Buell Co., 205 Davidson Bldg., Sioux City. Complete plans about Jan. 15. Roy Kinne, City Clk.

Jamaica, Kingston—Government of Jamaica plans to expend $1,750,000 for extension of sewerage and water systems of Kingston. Power station estimated at $180,000 will be erected and street lighting will be improved.

Mo., Odessa—City will probably soon advertise for bids for impvts. to water works system. $100,000 bonds recently voted. E. E. Harper, 3031 Park Ave.. Kans. City, Mo., Cons. Engr.

Minn., Sauk Center—Meeting held to discuss plans for impvt. of water works system. Cons. Engr. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, recommend reservoir on north side river, 30 feet deep, 40 feet across and 150,000 gal. conc. and steel standpipe at Grove Lake Ave. J. F. Cooper, City Clk.

Mo., St. James—Comm. on water, sewerage and light submitted report at meeting of Board of Aldermen. Div. of money made as follows: Water works consisting of deep well, elec. pump. brk. pump bldg., 75,000-gal. tank on a 100-ft. tower, these to be constructed on city lots, water mains and water departments—$200,000 for Light Dept. sepic tank, $10,000, etc., etc.

Neb., Lincoln—Resolutions passed by City Council authorizing a $300,000 bond issue for city light and water department—$200,000 for Light Dept. and $100,000 for Water Dept.

Neb., Palisade—Jim Fitzgerald and H. L. Hunt appointed by Mayor to prepare plans and call for bids for constr. of city well. H. L. Hunt, Clerk.

N. C., Raleigh—City will construct 250,000,000-gal. impounding reservoir at Yates Mill; constr. addition to dam; increase capy. of Lake Raleigh from 171,000,000 to 250,000,000-gals.; remove present intake to Lake Raleigh; increase capacities of pumping and filtr. plants from 3,000,000 to 5,000,000 gals.; erect 750,000-gal. capy. steel tower. Approx. total cost $500,000. Wm. C. Olsen, Cons. Engr., Kinston, N. C.

N. C., Southern Pines—City will improve water and sewer systems; plans issuing $25,000 bonds. Gilbert White, Durham, N. C., Cons. Engr.

N. C., Warsaw—City plans improving water and electric lighting systems; will issue $25,000 bonds.

Okla., Mill Creek—$50,000 bonds voted for installing water works.

Ore., Salem—City of Eugene, thru its Water Board, applied to St. Engr. Percy A. Cupper, for permission to appropriate 2.900 second ft. of water from McKenzie river to power development. First application is for 2,500 second ft. and it is evident that dam will be constructed 75 ft. high and 300 ft. long with a spillway.

S. D., Vermillion—Prelim. survey made for sinking reservoir in sand basin across Vermillion river, water supply from Missouri. Will connect with present pump plant by iron mains. J. W. Brown, Vermillion, submitted plans. C. L. Vaughn, City Clk.

S. D., Watertown—Prelim. plans made for impvts. to filtr. plant and pumps. Geo. K. Burt, Secy. of Pub. Utilities Comn. $50,000.

Tenn., Chattanooga—City Water Co.—M. F. Riley, Pres.—will improve water works, extend mains; improve pumping station, etc. Approx. cost $100,000.

Tex., Corpus Christi—Nueces Co. water impvt. Dist. No. 3 will improve water works and irrigation. $300,000 bonds voted.

Tex., Galveston—H. L. Durland, Cons. Engr., will be retained by City to prepare plans and specfs. for installation of new plant (Alta Loma water plant). Bids will be advertised for oil engine plant. Approx. cost $117,000.

Tex., Walnut Springs—Among impvts. planned for new year is complete water system, a petition signed by large majority of voters having been presented to City Council.

Va., Richmond—City will extend water works; enlarge storage facilities; $1,500,000 bond issue approved.

Va., So. Boston—City will expend about $50,000 to extend water mains. R. R. Hamilton, Archt., Box 64. E. R. Farmer, Engr.

W. Va., Huntington—Huntington Water Co. plans expendt. of $375,000 to improve water works; install pump at 24th St. station; increase capy. to 5,000,000 gals.; 2 filters, increasing filtr. capy. 25 per cent; conc. sedimentation basin; 12 to 16-in. main from pumping station to reservoir.

Wis., Fall Creek (P. O. Bracket)—Prelim. plans under way for sewer and water system. Archt.-Engrs. Toltz, King & Day, Inc., 1410 Pioneer Bldg., St. Paul, Minn. Pump house, tower 80 ft. high, tank 80,000 gals. steel water mains and hydrants and sewage disposal plant. Will build next spring. $50,000.

Wis., Waupaca—Plans under way for new water supply system. W. G. Kirchoffer, Cons. Engr., Madison, recommends gravel-packed well, 30 ft. diam., 36 ft. deep, capy. 1,100 gals. May purchase new house meters and 1 or 2 pumps. F. A. Houseman, City Clk. Est. cost $28,500.

BUYERS' GUIDE

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Sanitary Supplies.
Integrity Chemical Co.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
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